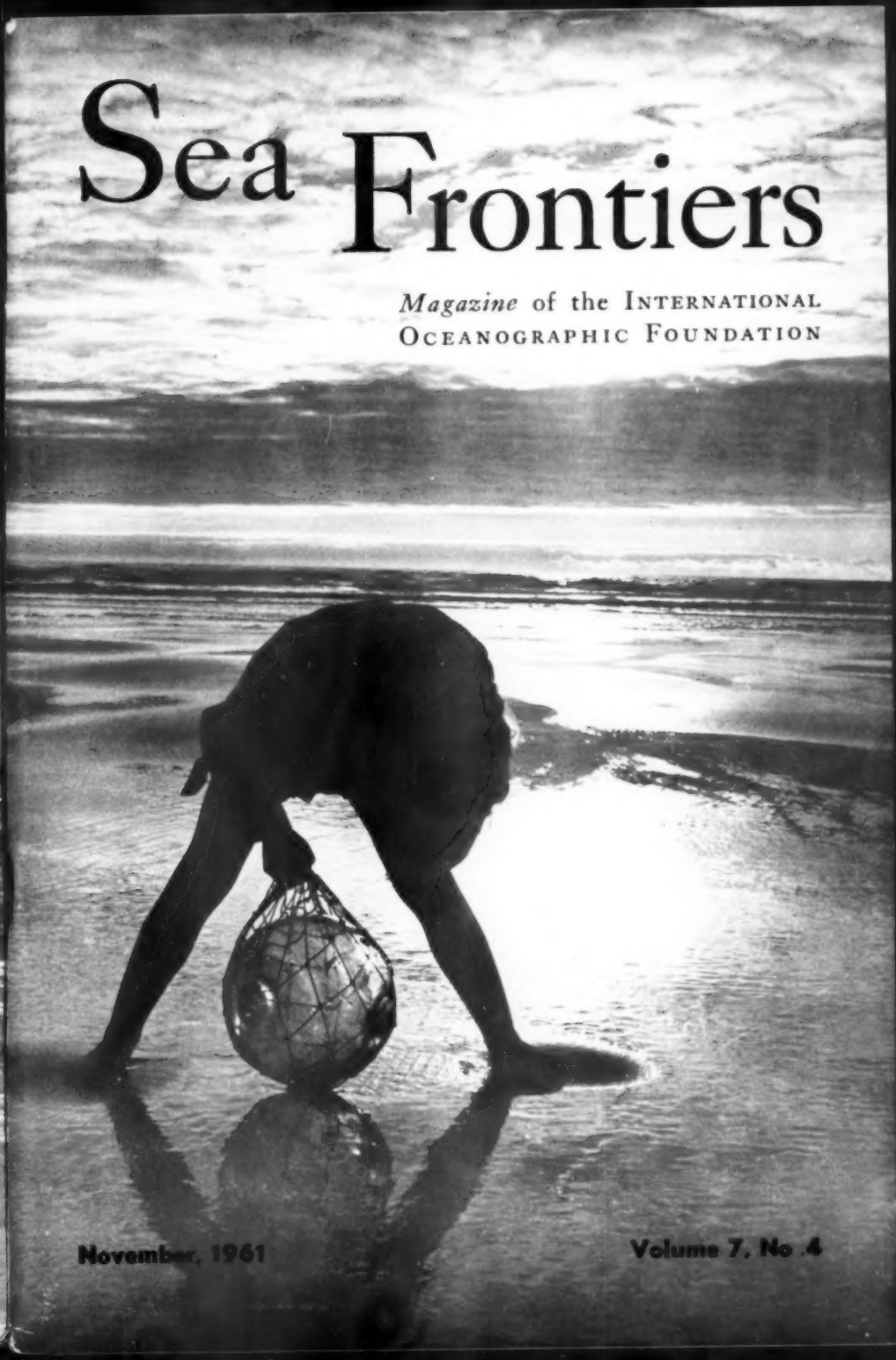
Sea Frontiers

Magazine of the INTERNATIONAL OCEANOGRAPHIC FOUNDATION



November, 1961

Volume 7, No. 4

STOP, THIEF! *This large scorpion shell was collected in the Society Islands and left in the sea for final cleaning by nature. Several days later it mysteriously disappeared and in its place was an old, eroded terebra shell. About 100 feet away the new shell was found being carried about by a small hermit crab who, having outgrown his former home, was simply setting up housekeeping in this spacious new one. (John E. Randall)*

FRONT COVER. CHRISTMAS TREE *ornament from Mars? No, the sphere encased in the net is a glass float used by the Japanese for their fishing nets in the Pacific. Glass floats are preferred because they are more buoyant than floats made of other substances. (Washington State Department of Commerce News Bureau)*

BACK COVER. ROMAN LIGHTHOUSE, *situated 380 feet above the English Channel, is within the precincts of Dover Castle. Originally 80 feet high with a beacon on top, it is the earliest permanent work of the Romans in Britain, built not later than 50 A.D. (British Information Services)*

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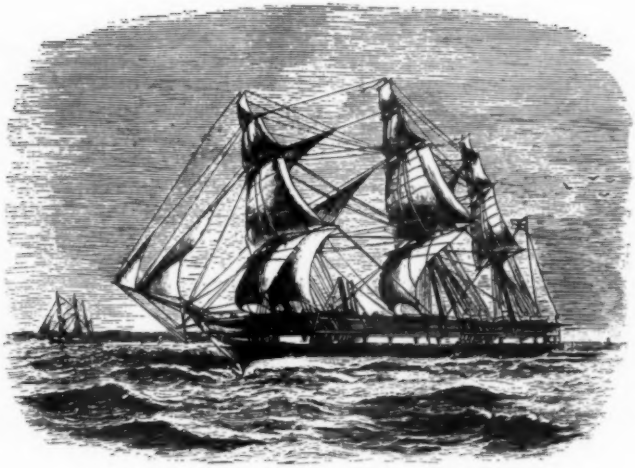
Table of Contents



VOLUME 7, NO. 4 NOVEMBER, 1961

FREDRIK BEYER, *first Nordic-American Exchange Fellow to work in this country on a grant from the Foundation, employed his ingenious deep-sea sled net with great success both for specimen collecting and for underwater photography. (Jerry Greenberg)*

Report to Members

This has been a year of growth for the Foundation. In several areas, particularly scientist exchange and scholarship grants, the Foundation has taken steps to further its mission of providing active support for scientific education and investigation.

Industrial and engineering groups have sought the Foundation's consultation and advice in underwater development problems. Programs initiated by corporate associates of the Foundation at universities have also been of indirect benefit to industry. Among them is the problem of limestone sedimentation, of vital interest to the petroleum industry.

Instrument loans have provided critically-needed equipment and facilities for increased scientific study. In a more general way, a valuable service has been provided in answering the more than 1,500 inquiries sent in during the past twelve months by people from all walks of life who possess an interest in the seas.

First Nordic Exchange Scientist

What is the Foundation doing in the way of research fellowships? A tangible answer was provided recently when the first Nordic-American Exchange Fellow to work in this country on a grant from the Foundation returned to Norway after six fruitful months at the University of Miami's Institute of Marine Science. But Dr. Fredrik Beyer, whose ingenious deep-sea sled net was employed in this country for the first time in collecting and research at the Institute, is but the first of many Scandinavian scientists who will work in this country while their fellows study in the Nordic nations.

This program provides marine biologists of the Scandinavian countries with an opportunity to extend their experience from the colder Northern seas to tropical waters. At the same time, the exchange gives American scientists from the Atlantic tropical regions a chance to compare their observations with conditions in Northern European waters.

The exchange program is arranged by a committee of leading marine biologists from the Scandinavian countries and the United States, together with several leading citizens of the Nordic countries. Among them is a distinguished Nobel Prize winner, Thor Heyerdahl.

Something Very Different

Although he was the first Nordic exchange scientist, Dr. Beyer effectively demonstrated the worth of the program. In the Tongue of the Ocean he discovered a previously unknown species of Cephalopoda. Off the Dry Tortugas, his sled collected more pink shrimp eggs and larvae than had been taken in regular nets during several years of pink shrimp investigation.

Dr. Beyer was able to develop a technique of high-speed bottom photography by mounting an underwater camera on his famous sled. And although most of his half-year was devoted to research and collection at Miami, he found time to lecture and

THROUGH THE FISHERMEN'S SCHOLARSHIP *the Foundation aids worthy prospective marine scientists who are sons of charterboatmen or fishermen, or who have been fishermen themselves. David Marra, Clyde Roper and Walter Starck (left to right) have been able to continue their graduate studies and individual research without financial interruption. (Walter Courtenay)*

exhibit his most recent underwater slides and motion pictures at Woods Hole Oceanographic Institute in Massachusetts, the New England headquarters of the U. S. Fish and Wildlife Service, and Harvard.

Dr. Beyer's own words sum up many of the reasons for this program: " . . . pictures were gradually built up in my mind of habitats and plant and animal communities previously entirely alien to me, pictures that could never have been obtained through reading alone, pictures that will influence not only all my future thinking concerning subtropical and tropical aquatic life, but also affect my attitude toward marine biological relations and problems in general. There is no better way of broadening one's mind than to see and experience something very different and completely unfamiliar."

Sons of Fishermen

Still another facet of the Foundation's support for research and edu-

cation is the Fishermen's Scholarship, given to worthy prospective marine scientists who are sons of charterboatmen or fishermen or, in some cases, fishermen themselves.

During the past year these grants provided an opportunity for three graduate students to continue their studies and individual research without financial interruption. Two are ichthyology majors, Walter Starck II and Clyde Roper; one, David Marra, is studying physical oceanography.

Starck, who this year accumulated twenty collections of Mediterranean shore fish for a university museum and several other collections while on the Gould expedition to New Zealand, has described four new species of sea bass relatives which he discovered. A recent paper of Starck's, relating his discovery of a swordfish spear imbedded in a shark, was published in the *Quarterly Journal of the Florida Academy of Science*. The son of a Florida Keys fishing guide, Starck himself is an experienced angler.

Roper was a successful commercial lobster fisherman when he was only fourteen. His Master's thesis has provided the first full scientific description of the bathypelagic squid, a brilliantly luminous deep-sea animal little known before now. Previously, only two short lines of Latin described this squid. Roper has determined its limits, external characteristics, anatomy and proportional growth from the larval stage through adulthood.

David Marra, whose Portuguese ancestors have fished the oceans for several generations, has participated in over 200 offshore research cruises at the Institute of Marine Science of the University of Miami. During his three oceanographic expeditions last year, Marra plotted the profiles and exact position of two newly discovered undersea mountains in the Tongue of the Ocean, Bahamas.

Instrument Loans

The Foundation has aided scientific research in other ways. Instrument loans during the past twelve months provided a refrigeration building for the storage of deep-sea sediment cores. These cores, which are utilized in studies of marine sedimentation by Dr. Cesare Emiliani and Dr. Eugene Rusnak, require low temperatures to maintain them in the original condition at which they were found deep in the ocean, where the temperature seldom varies from 2-3° centigrade. Otherwise, bacterial molds would spoil the cores for certain types of research.

Another loan from the Foundation provided audio equipment for a radar meteorological laboratory. A special oscilloscope and preamplifier, also paid for by an I.O.F. loan are being used in marine meteorology studies.

Hundreds of Questions

Sea Frontiers, Hints for Sailors and *Sea Secrets* are well known to members and practically everyone else who follows the sea. *Sea Frontiers* continues to increase in circulation, for Foundation membership has almost doubled this year. *Hints for Sailors* was distributed for the second successive year to an even larger

LOANS *from the Foundation provided a refrigeration building for the storage of deep-sea sediment cores. These cores require low temperatures to maintain them in their original condition; otherwise, bacterial molds would spoil them for certain types of research. (Don Heuer)*

number of yachtsmen, anglers and fishermen. And over 1,500 inquiries were mailed in to the Foundation's popular question-and-answer service.

The most interesting of these questions are printed in the I.O.F. monthly newsletter, *Sea Secrets*. Last year they ranged from an inquiry about the edibility of sand fleas to questions about the chemistry of sea water. One correspondent asked about mullet gizzards, while still another wanted to know if it was true that fish swallow stones for ballast when a bad storm is coming. A fisherman told us he had found "pearls" in catfish. In every case, an authoritative answer or comment was provided by competent scientists.

The Year Ahead

The International Oceanographic Foundation does not intend to rest on its laurels. Grants to support research and education will be continued. Other marine science students who have practical experience in fishing or belong to families of commercial fishermen or guides will receive financial assistance in the coming year.

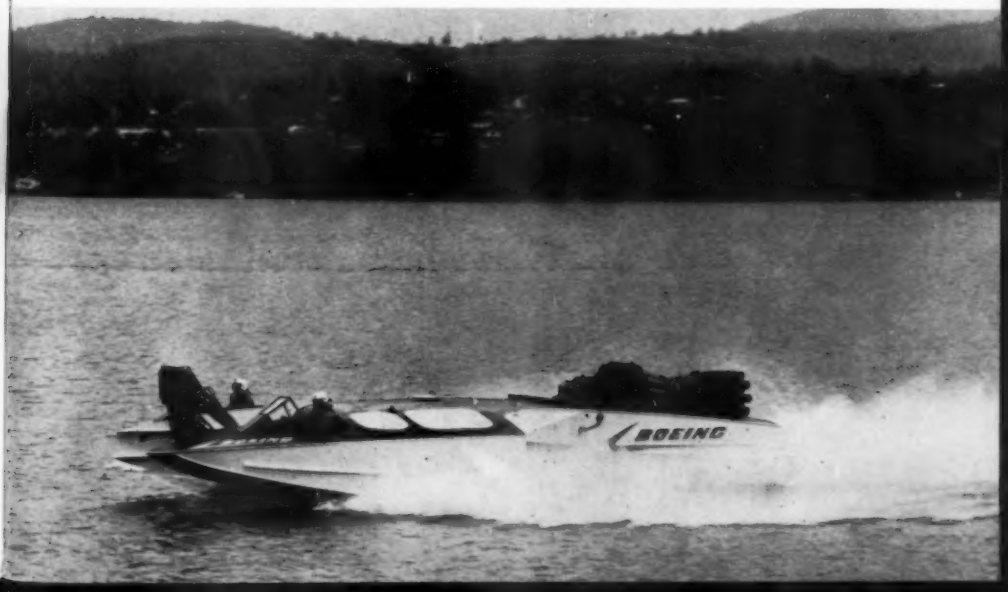
As funds permit it, a second Nordic scientist will study in tropical waters and an American will spend six months at a Scandinavian station.

Improved services and continued development of authoritative articles in *Sea Frontiers* are assured with the recent appointment of a number of leading scientists from various parts of the world to the newly established Advisory Council. When membership increases sufficiently, the Foundation's ultimate objective of making *Sea Frontiers* a monthly color magazine will be realized. Meanwhile, it is hoped that the number of issues will increase to five, and possibly six, next year. As always, continued effort will be expended to focus attention on the scientific study of the sea and to encourage public interest in the marine sciences and the oceans.

Lobster Boats?

A claw-shaped boat, 38 feet long and weighing 12,000 pounds, has been designed to test various marine shapes, such as hydrofoils and hulls. Testing is done by holding a model between lobster-like pincers and driving it through the water at high speed. Named the *Boeing Aqua-Jet*, the boat can do 100 knots and is propelled by a conventional aircraft jet engine like that used in the Air Force's T-33 jet trainer. It steers by twin underwater rudders, one at each of the stern corners.

The *Aqua-Jet* will reveal the reactions of models at various speeds, angles, and depths. Among advanced marine designs being tested is a section of a hydrofoil—the lifting surface on which hydrofoil boats ride. One purpose of the studies will be to research super-cavitating hydrofoil designs, an effort similar to the wind-tunnel testing of wings for aircraft.



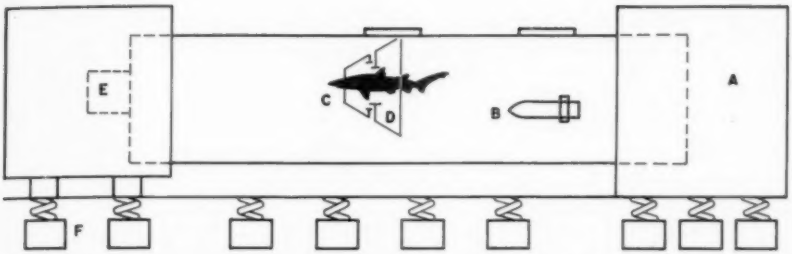
SHARK IN HARNESS *has anesthesia administered prior to placement of electrodes. Harness is then placed in the drainpipe, where strapped-in shark revives. Then scientists begin playing sounds to the subject and measuring its heartbeat. (Don Heuer)*

Do Sharks Hunt By Ear?

By JAMES WILES

A FASCINATING scientific study is currently involved in unravelling the mystery of the "invisible shark" that so often appears from nowhere to startle both anglers and divers. This investigation subjects these underwater marauders to the unusual experience of facing a lie detector and occupying not the usual aquarium tanks, but massive drainpipes!

Tournament fishermen in particular often are surprised by the uncanny ability of sharks to find their prey. Practically every day, an angler experiences the acute disappointment of pulling in a mere shark-mutilated fragment of what he anticipated might be a record catch. Marine bi-



SHARK IN A DRAINPIPE! *This unusual apparatus allows scientists to make precise measurements of shark hearing. A. Gravel and sand in water absorb sound so as to prevent disturbing echoes or reverberations in the drainpipe. B. Hydrophone, which measures the actual sound heard by the shark. C. Shark, strapped into a specially designed sled, is isolated from all extraneous sound, light, or other distractions within the light- and soundproof drainpipe. D. Electrodes for shock punishment. E. The sound source—a transducer. F. Dampened springs, which absorb any low-frequency sounds from outside, which might interfere with the experiment. Salt water circulates through the pipe. (Richard Marra)*

ologists have known for a long time that sharks possess a well-developed sense of smell which enables them to detect quite small amounts of blood in the water. Using this sense, they readily pick up traces of blood carried downstream to them by currents and tidal movements. But how can scientists explain the mystery of sharks which appear from *upstream*, with no possible chance of smelling the blood? Is it likely they also have very acute vision and can see their prey at a considerable distance?

Sixth Sense?

Apparently vision is not enough to account for the shark's precise sleuthing. Skindivers have reported that a fish flopping on a spear seems to attract sharks, even when none were originally in sight. At times when their view is obstructed by rocks, numbers of sharks still may suddenly appear like magic and head for this easy catch.

Something other than sight or smell, it would seem, draws sharks to a fish in distress. Can it be possible that sharks hear—and are attracted by—the sounds of a struggling fish? Unfortunately, in the case of many fishes no audible sound has been detected. But one other possibility remains. The movements of a fish cause vibrations or pressure variations in the water, far below the range of the human ear. Perhaps when a fish is wounded or dying these sounds differ enough from those produced by normal movement for a shark to detect them readily.

Searching for Sounds

Dr. Warren Wisby, who is heading this long-range study of sharks at the Institute of Marine Science, University of Miami, definitely intends to find out. For the past year he has been supervising research into the shark's sensory systems, especially those connected with hearing.

DR. WARREN WISBY *and Joseph Richard make final check of transducer at one end of 16-foot black painted drainpipe. This is designed to reduce echoes and resonance sufficiently to permit accurate measurement of the hearing ability of sharks. (Don Heuer)*

In these studies Dr. Wisby and his associate, Mr. Joseph Richard, are trying to obtain basic information on the range and mode of action of shark hearing. Accompanied by appropriate studies of behavior, this can contribute materially to an understanding of how these animals may be able to detect the sounds produced by moving objects—both finny and human—and to distinguish between the sounds of normal swimmers and those in distress.

Two Hearing Systems

Two separate mechanisms of hearing aid the shark. The ears—the sacculus and lagena—are located inside the head and detect higher-frequency sounds. These two small channels are lined with sensitive hairs and imbedded in a jelly-like substance.

The shark's second hearing system, the lateral lines, may pick up low-frequency sounds. These familiar, well-marked lines run the length of the flanks of bony fish. They are a series of pits or tubes, connected by canals, which lie just under the skin. The tubes have sensory hairs, connected to a long cord of nerve tissue on each side of the body.

A related series of pits, the ampullae, occurs under the shark's snout. Along with the lateral lines, the ampullae may act as a sensitive receiver for detecting pressure changes and water movement. The utility of this apparatus as a sound receptor has not been fully investigated. How-

ever, what we do know of the part it plays in the discovery of underwater vibrations seems to indicate it could possibly account for the shark's remarkable ability to detect an injured fish and quickly swim to the scene.

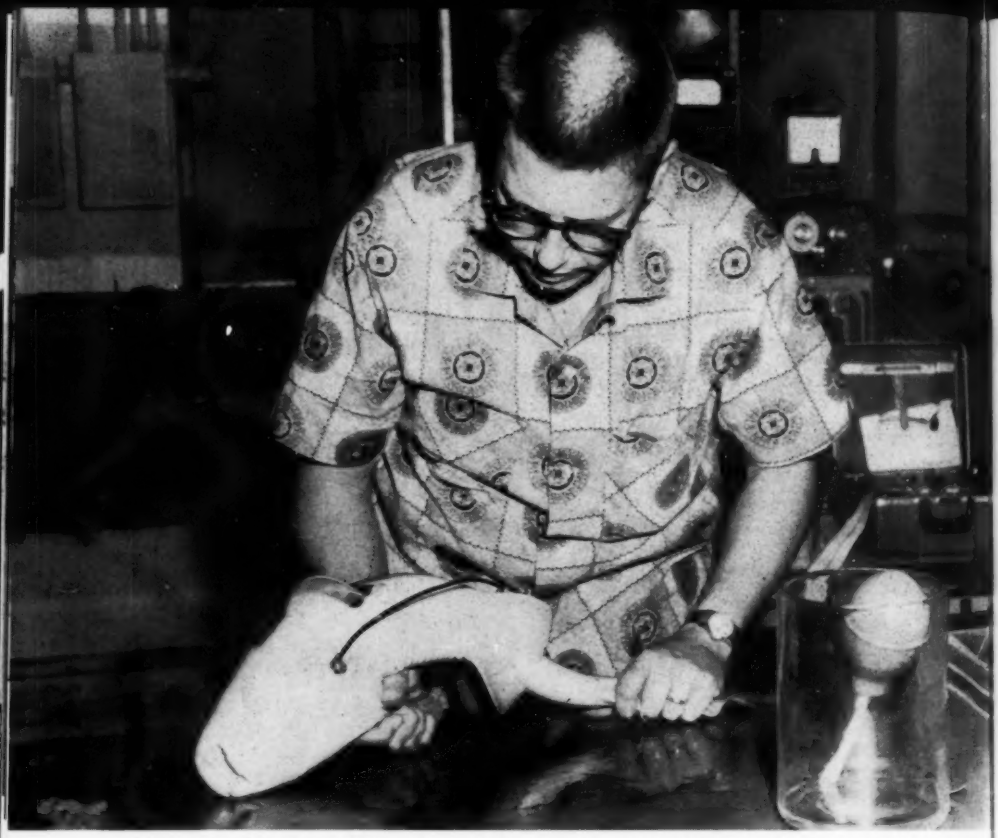
Sharks in Drainpipes!

Serious deficiencies in the techniques and equipment employed in most earlier investigations of shark hearing severely limited their effectiveness. In many experiments the sound was generated in the air, outside of the tank containing the fish. Often the sound sources were not calibrated and, in almost all instances, no attempt was made to check the sound levels inside the tank.

Dr. Wisby's group began by using an odd device in place of the small tanks usually employed. They selected a 16-foot long, 3-foot wide drainpipe (See diagram). This was not a whimsical choice, but one based upon good reasoning.

Apparently little attention had been devoted in previous experiments to the size and shape of the test tanks used. Small tanks may act like organ pipes, creating resonance and echoes that interfere with the sound played to the sharks. Dr. Wisby's drainpipe has adequately solved this problem. One end of this great tube is buried in a box of water-saturated sand which acts as an absorption chamber

ANESTHETIZED SHARK *has electrode placed for measurement of heartbeat. Nurse shark is used for experiments because of its relative docility and abundance in South Florida waters. (Don Heuer)*



SHARK LIE DETECTOR *allows investigators to know whether the subject is reacting to the sound. Here, the electrode has been firmly implanted into the heart region of the shark. The black wire leads to recording instruments. Electrode measures rate of heartbeat, which stops, then speeds up when the shark is exposed either to electric shock or to the sound. Association is formed quickly. (Don Heuer)*

and minimizes the reflection of sound waves back into the tube. This sound absorber, combined with the pipe's extensive length and rigid wall, sufficiently reduces echoes and resonance. Interfering outside noises traveling through the ground are eliminated by dampened springs that support the drainpipe and absorb low-frequency sounds.

This unique device also efficiently controls the transmission and monitoring of sound. The sound source, or transducer, is placed at one end of the long tube, the sound absorber at the other. Two calibrated hydrophones help check the sound.

The first, placed between the tube entrance and the strapped-in shark, indicates the sound heard by the fish; the second, a smaller instrument, may be moved to any position to measure sound intensity throughout the tube. A sound analyzer is used to let the experimenter know if sounds other than the one he is trying to play to

the shark are present in the drainpipe.

In this unusual drainpipe, sharks can be tested at various sound strengths and frequencies. The hearing limits of different species can be measured under conditions which allow the transmission of a sound closely approximating the underwater signal a shark normally receives.

Controlling Conditions

Employing precise stimuli in controlled surroundings, the investigator plays a predetermined sound to the shark with complete assurance that the subject is responding to the intended signal, not to overtones or background noise. Distracting elements such as light are eliminated by the windowless pipe. Practically for the first time, the marine scientist is able to obtain knowledge about shark hearing in the *right* way.

Shark "Lie Detector"

Another interesting feature of these experiments is that measurements are made of the shark's heartbeat for a purpose similar to that of the lie detector. There is a reason for this.

It is not sufficient simply to *watch* the shark's reaction to a particular sound, no matter how efficient the equipment employed for the investigation may be. A shark's visible reactions to the same sound may vary a great deal, or the creature may even choose to pay no noticeable attention at all, according to circumstances.

How can scientists always be certain whether a shark hears or not? Ways have to be found that will permit the conditioning of sharks for more reliable laboratory indications of their hearing ability.

Sharks Have Sensitive Hearts

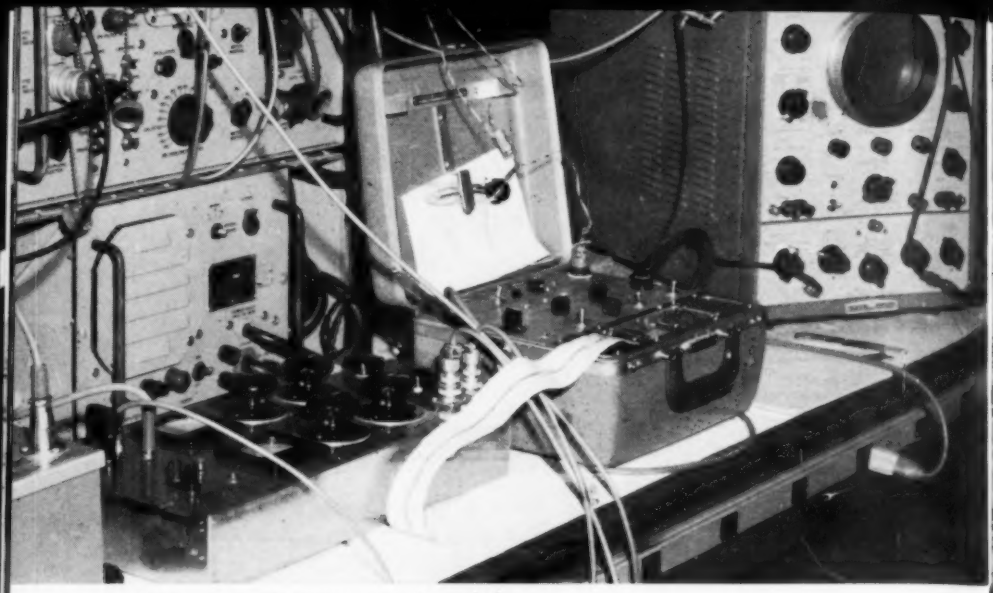
One such conditioning process uses the shark's heartbeat to let the investigator know that the shark has reacted to the produced sound. The immobilized shark, fastened to a board, is placed in the drainpipe. Punishment electrodes are placed on either side of the subject; then the heartbeat is measured.

When this experiment was first conducted by Dr. Wisby's group, it was discovered that if the shark was frightened by loud sounds, tapped with a stick, or touched by the investigator, the heart stopped beating for a short period of time, and then speeded up to a tempo far faster than its normal rhythm. The same result was recorded when electric shock was administered. The association between electric shock and sound was formed easily and rapidly, indicating that sharks can be made to react in a perfectly automatic manner to certain stimuli.

More important, the experiment proved that heartbeat can be used as an indicator of learning, at least in certain species. Even when the shark fails to respond outwardly to a sound, measurement of the rate of heartbeat will reveal a response.

Importance of These Tests

Of what value are such investigations? Can intensive probing into shark hearing provide anything of



RATE OF HEARTBEAT, *monitored by electrocardiograph, is continuously recorded on this electrocardiogram for precise checking by scientists. A great variety of electronic and audio equipment is required for this study of shark hearing. (Don Heuer)*

value to anyone other than the marine scientist? Dr. Wisby thinks so. For one thing, there is the theory that sound, as well as sight or smell, may guide the shark to its victim.

It is probable that a sound similar to the kind of low-frequency vibration that wounded fish send out is emitted by a swimmer thrashing around in the water. Since sound travels through water at about 5,000 feet a second, a shark three or four miles away could conceivably pick it up, providing there was a low level of background noise in the shark's immediate environment. If his hunger or curiosity were aroused, he could swim at about 7 m.p.h. and be at the man in approximately thirty minutes.

If this is true, it would be wise for swimmers to use steady, rhythmic strokes. The more smoothly a man swims—the less his movements resemble the convulsions of a floundering fish—the less apt he is to attract the attention of a shark.

This research may ultimately provide conclusive proof that could save the lives of countless bathers who unknowingly simulate the sounds of struggling fish when they swim. Less concerned would be skindivers, as underwater swimmers generally move more slowly and evenly through the water than surface swimmers. In fact, statistics indicate that bathers and surface swimmers are attacked far more frequently than divers.

"Scream" Theory

Another related idea that is receiving attention is the so-called "scream" theory, which suggests that not only can sharks detect shouting underwater, but that they may actually be deterred from attacking by this

means. The pearl divers of Ceylon, who work among swarms of sharks, claim they can chase them off merely by shouting.

This approach may give man another weapon for his war on dangerous sharks. It is just possible that there exists a wide series of vibrations in the water that will attract or deter sharks. If there is, it should now be relatively easy to discover what these vibrations are and to reproduce them artifically. Once methods of attracting and driving off sharks have been perfected, positive systems of controlling their movements in the waters surrounding heavily-populated areas can be devised.

The inherent possibilities of these studies are limitless. Fishermen, skindivers, swimmers, sailors, marine scientists—all can gain from these investigations into the detection of underwater vibrations by sharks. Beyond this, the related research into the effect of various sounds on sharks which will stem from these first experiments promises to further benefit the steadily increasing body of people who look to the sea for recreation.

New Oceanic Gateway and Seafloor Airport

An area west of Rotterdam is the site of "Europoort," scheduled by the Dutch for a 1965 opening to handle ships of 100,000 tonnage. It can accommodate the world's largest ships —including the *Queen Elizabeth* at 83,673 tons and the biggest tanker, whose dead weight is 85,618 tons. Its industrial processing plants for steel, chemicals and oil, and the largest drydocks, will serve the European Common Market via a network of thriving barge canal and other transport systems.

A few miles away, in Amsterdam, passengers disembarking at Schipol Airport may well be amazed to see boats and barges on nearby canals floating thirteen feet above the airliner's runway. The airport was built on land reclaimed from below the level of the sea.

Bronze Age Shipwreck

Archeology, while not strictly a marine science, has developed enormously with the expansion of skin diving and the perfection of self contained underwater breathing apparatus (SCUBA). From Bodrum, Turkey, a home port of Turkish sponge divers, comes a report of the discovery of a galley wrecked 3,300 years ago. The Bronze Age ship, probably the oldest shipwreck ever found, yielded remnants of a cargo of Bronze Age artifacts, including axes, picks, sword blades and sheets of copper in oxhide shapes. Off Yassi Island, a veritable graveyard of ancient merchantmen, scores of old wine jars, or amphorae, were recovered.

The Curious World of Captain Symmes

By JOSEPH L. PARKHURST, JR.

During the course of scientific history many strange ideas have been advanced to explain the nature of the earth and its oceans. One Sixteenth Century explanation of the Gulf Stream, for instance, was that near the North Pole was a great Black Rock, next to which all the water was engulfed into the bowels of the earth.

The idea of a hollow earth into which the seas poured endlessly may seem appropriate enough for those times, but we find it again in Nineteenth Century America. This remarkable theory turned up in a printed circular mailed from St. Louis, on April 10, 1818, to all institutions of learning in America. In this circular the sender announced that the earth was not solid, but consisted of several hollow spheres, each having large openings at the poles, through which light and air were admitted.

He wanted financial aid and volunteers for a winter expedition over the frozen Arctic Ocean, to be launched from Siberia with reindeer and sleds. After advancing to 83 degrees north latitude he forecast warmer weather and abundant life, including the first contact with people living in that weird inner world.

Gains a Small Following

This hollow world scheme was conceived by John Cleves Symmes in the backwoods of Missouri and might have been drawn from newspaper stories covering the exploits of American sea captains in uncharted waters. A few months after publishing the theory he moved to Kentucky, determined to spend the remainder of his life writing and lecturing on hollow spheres.

In spite of the fact that his arguments were somewhat disjointed, the lectures drew sizeable audiences in Kentucky and Ohio, and the retired army officer gradually attracted a small following.

Here is How it Worked!

Symmes imagined a spinning mass of unformed matter, thrown from its axis by centrifugal force, then held together at a certain distance by means of gravity. The result of this delicate balance was an outer globe with a crust one thousand miles in thickness, and a number of lesser spheres suspended inside it. Although similar views had been expressed before, even in scientific circles, Symmes' concept of gaping holes in the earth's crust at the north and south poles seems to be an original contribution.

When a ship sailed over the wide rim of such an opening its captain and crew would be unaware of this event until they had traveled a long distance inside the huge tunnel. The

SPHERES WITHIN SPHERES. *While it is difficult to believe today, a small but active group once subscribed to the hollow-world theory of a retired Army Officer, John Cleves Symmes. Symmes was unsuccessful in obtaining either private or government support to carry out exploratory work, but his dream ultimately stimulated efforts to reach the ends of the earth. (From Symmes' Theory of Concentric Spheres, 1878 edition, Louisville, Ky.)*

rim of *Symmes' cavity* could be identified by extremely high tides, caused by the simultaneous rise of the inner and outer oceans. Because large masses of ice surrounded the rim, Captain Symmes reasoned that animals like the seal and polar bear could not subsist in this frozen waste, but fattened in the sea beyond

Another Symmesian phenomenon was a double cloud formation, supposed to be visible at night from the South Atlantic, while looking across the south polar opening. In his mind's eye the two persistent clouds near the other side of the yawning chasm were the images of Australia and New Zealand, reflecting the bright sunlight.

Symmesites appealed for a government-sponsored expedition, to be sent to the Arctic in search of the truth, and the plan reached Congress in

ORIGINATOR OF THE STRANGE THEORY *that the earth consists of several hollow spheres, John Cleves Symmes spent much of his life in a vain effort to convince institutions of learning, newspapers, the Congress and the public. (Ohio Historical Society Library, Columbus, Ohio)*

1823. In January of that year a petition with many signatures was submitted by a representative from Kentucky, urging legislative support for Captain Symmes, and a party of scientists to verify his findings. Similar proposals from Ohio were placed before both houses of Congress, although none of these received sufficient backing, and the whole matter was tabled.

Continuing the lectures, he decided on a joint tour of the large eastern cities with Jeremiah N. Reynolds, an editor and school teacher, who had taken a serious interest in the subject. When Symmes' health failed, and he was obliged to give up, Reynolds dropped the hollow-earth theory, and pressed Congress on the need for further exploration of the southern hemisphere. Symmes did not live to see the outcome of this. His dream ultimately stimulated a national effort to reach the ends of the earth however, since it was partly responsible for the Pacific Ocean survey of Lieutenant Charles Wilkes (USN) which also mapped a sizeable portion of the Antarctic Coastline.

In Defense of the Turtle

By STEPHEN SCHMIDT AND P. ROSS WITHAM

OVER THREE-QUARTERS of a century ago, the U.S. Life Saving Service built a lonely outpost on the rocky shores of Hutchinson Island, just east from the present town site of Stuart, Florida. Known as a House of Refuge, it furnished aid, shelter, food and clothing to stranded sailors who were shipwrecked off Gilbert's Bar, an extensive reef along this part of the coast.

Turtles Can Drown!

Today, the House of Refuge has been restored as an historic house museum, and although it no longer acts as a life-saving station, it still holds a unique role as a House of Refuge—for sea turtles!

This project had its beginning in the fall of 1955, when Mr. Ross Witham, of Stuart, found, while strolling along the beach near the museum, a nearly drowned baby loggerhead turtle. It may seem strange to find a creature that spends almost all of its life cycle in the sea in a nearly drowned condition, but it is something that can easily happen to a baby turtle. Entangled in seaweed, the baby loggerhead could not escape.

SURVIVAL IS NO EASY MATTER *for most green turtles. This fortunate specimen, protected from man and animals, swims gracefully in contentment at the Miami Seaquarium. (Miami Seaquarium)*

THE HOUSE OF REFUGE MUSEUM *on the rocky shores of Hutchinson Island, east of Stuart, Florida, now provides a unique refuge for defenseless baby sea turtles. (Ed Glucker)*

Since the rescue of this baby sea turtle, the House of Refuge Museum has launched an intensive plan for the conservation of these reptiles. They have decreased alarmingly in the past five decades. Indian mounds along the east coast of Florida indicate to a large extent that the turtles were taken in great quantities and constituted a major food item of our coastal natives in pre-Spanish days. For three hundred years after the settling of the Caribbean, the fleets of breeding green turtles played a prime role in the growth and development of communities there.

From 2,500 Down to 60!

In the 1880's stakes of the turtle nets with palmetto leaves fastened to the tops dotted the Indian River for miles. One turtle fisherman, Mr. Charles Parke, was quoted as having caught 2,500 turtles in eight nets in the Indian River district in 1886. However, in 1895, he was able to land only sixty animals using six nets. At the present time, few turtles are caught for the Florida market.

What can we do to preserve the rapidly diminishing population of these giant reptiles of the deep? Many factors work against the survival of sea turtles. Prolonged cold spells and hurricanes take an extensive toll. Reports from various sources indicate that sharks mutilate adult turtles and even dispose of entire animals up to fifty pounds. Housing developments all along the east coast of Florida have robbed the turtles of their natural breeding grounds, forcing them further south to the Caribbean area to lay their eggs. And, if eggs in a nest survive destruction by digging racoons, young hatchlings must run quite an obstacle course en route to the water. Entirely without parental supervision and training, the slow, disorganized march of baby turtles makes them easy prey for birds, crabs, and predatory animals. Large rocks (which they may not be able to go over or around), masses of seaweed, and attraction to artificial light may lead them far away from the water.

BABY SEA TURTLES *are quite helpless when first hatched in sand nests. On their trek to the sea they are easy prey for birds, crabs, and predatory animals, to say nothing of the large rocks that may obstruct their path and the masses of seaweed in which they might become fatally entangled. (Florida State News Bureau)*

Man Also an Enemy

Once they reach the water, they are again easy meals for larger fish and birds. Needless to say, the numbers who may survive an average batch of eighty to one hundred eggs in the sand have been greatly reduced. And those who do survive must remain in the sea from four to five years before they can reach maturity and return to the beaches to continue the life cycle in laying their eggs. And finally, at this point, they are extremely vulnerable to man. Poachers flip the big turtles over on their backs, rendering them helpless (often before they have had a chance to lay their eggs), in order to pack them later for butchering.

With many of these things in mind, the House of Refuge Museum, operated by a nonprofit organization, the Martin County Historical Society, requested and received a permit from the Florida State Board of Conservation. This permit allows it to take turtle eggs from the beaches and transfer them to the protected

TURTLE EGGS ARE TRANSFERRED *from beaches to the protected grounds of the Museum for incubation and care after hatching. The turtles are raised in tanks for six months or more until they are large enough to insure a better chance of survival. Hawksbill, loggerhead, and green turtles have been hatched and raised successfully. (Florida State News Bureau)*

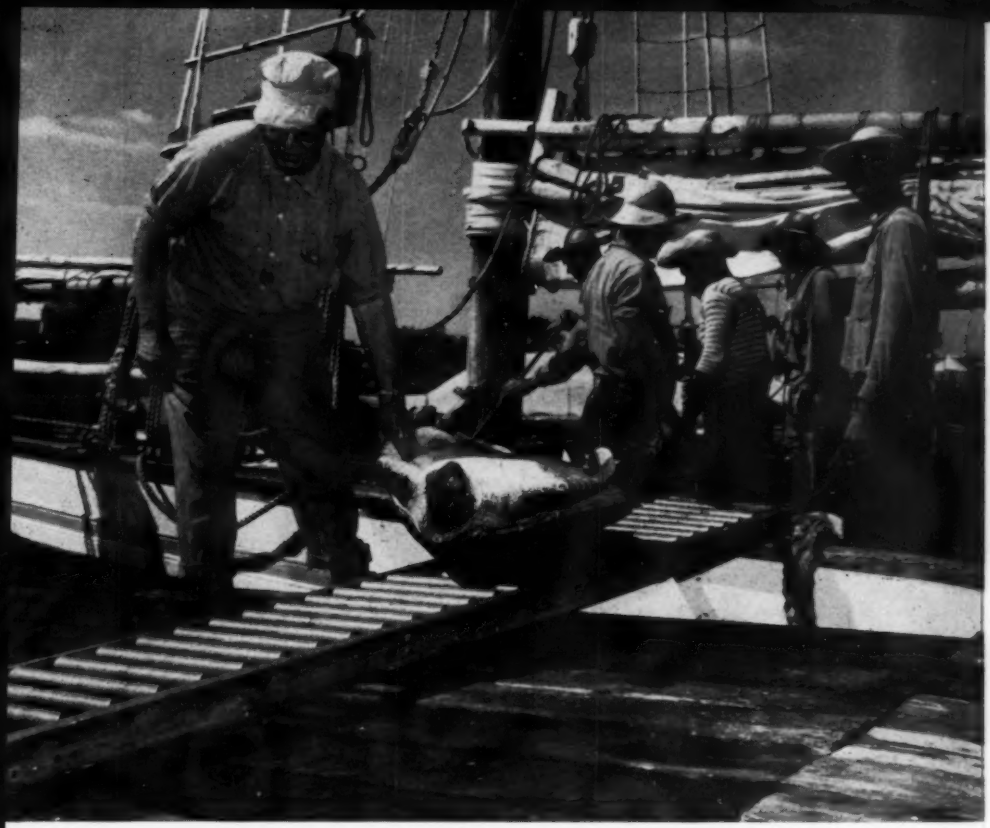
A HUGE TRUNKBACK *turtle lays her eggs on a stretch of beach near the Museum. Four year old Aida Gale of Stuart shines a spotlight on the nest. (Stuart News)*

grounds of the Museum for incubation and care after hatching. The turtles are raised in tanks until they are large enough to insure a better chance of survival.

Success! Despite Primitive Facilities

The first eggs were transplanted in 1956, one nest of 109 loggerhead eggs in August and another nest of 107 loggerhead eggs in September. From the first batch thirty-five babies hatched, and from the second, ninety-two were hatched. Facilities for keeping the young at that time were practically non-existent, but a small pool was scooped out of the sand and lined with plastic. These pools held the water very well, but since there was no pump, buckets of water had to be carried from the river. Volunteers had to scale an embankment of almost 100 feet without spilling the water!

Later, a gasoline-driven pump was given to the Society (there was no electricity on the island at the time), with enough plastic pipe to run from the Museum grounds to the river. Delighted with their entrance into the world of modern technology, members of the Museum transferred the turtles to larger quarters in an old dugout canoe and kept them there



THE TURTLE INDUSTRY *will benefit from new turtle-conservation methods undertaken recently. Here a green turtle is landed from a sailing ship and sent along a conveyor belt for later processing. (Florida State News Bureau)*

until it was possible, through donations of interested persons, to provide a small concrete tank.

When Mr. Stephen Schmidt assumed the directorship of the House of Refuge Museum in November, 1958, he placed the Turtle Conservation Project high on the list of the Museum's functions and services. At the present time, facilities have improved greatly. There are now two concrete tanks of adequate size, and both are supplied with fresh sea water daily by an electric pump. Also in use is the House of Refuge's old cistern which was excavated and is about five feet deep and fourteen feet in diameter. Here some of the larger specimens of each species of turtle are kept for public viewing. Swimming in the cistern tank is one of the loggerhead turtles, hatched from the first batch at the Museum. It is now over four years old and very large in size. In 1960 two of these larger turtles, a green and a loggerhead, were sent to the Cincinnati Zoo, where, from all reports, they are continuing in good health and growing rapidly in the public aquarium.

Sea Turtles in River

It is believed that after the young turtles have attained a carapace length of six to eight inches (about six months to a year in age) they are big enough to be released into the local waters and stand a fair chance of survival. Since the Museum is located on a narrow strip of land between the ocean and the Indian River, the youngsters are released into the river rather than the ocean, as a much larger supply of food for them is apparently available in the grass beds of the river.

Turtles Enjoy Tomatoes!

Museum workers have hatched and raised three species of sea turtles at the Museum: the green turtle, the hawksbill turtle, and the loggerhead turtle. They have unsuccessfully tried to raise trunkback turtles, but found that, after hatching, they would not eat any food except ripe tomatoes! Since tomatoes are obviously not a part of their natural diet, it could only be concluded that they were attracted to brightly colored foods. The other turtle species which were raised from eggs collected on local beaches all prefer a carnivorous diet including almost any kind of animal life from the sea, such as fish, crabs, anemones, shrimp, sand fleas, jellyfish, Portuguese man-of-war, sea slugs, sea hares, and shell fish.

For the young turtles, the shell fish must be broken open and the shrimp, fish, and crabs cut up or ground to a soft consistency. As they grow older, the loggerhead and green turtles include more plant food in their diet. They like potatoes, lettuce, and cabbage, but strangely enough, show little interest in seaweed. The hawksbill turtles showed no interest in anything but a carnivorous diet.

Green Turtles are Native Floridians

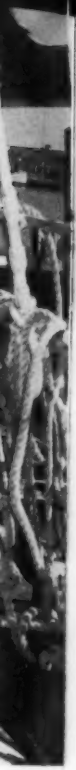
One of the main objects has been the restocking of green turtles in the Indian River area. It had been the opinion of the State Board of Conservation that this species did not lay in Florida. However, with the cooperation of the Board, and their Agent, Roland C. Byrd, of Stuart, a nest of green turtle eggs was actually obtained during August, 1958. The green turtle was observed laying her eggs on Hutchinson Island by Agent Byrd, who then delivered the eggs to the Museum. There were 105 eggs in

YOUNG VISITORS, *a boy and his dog, are shown some of the newly hatched green turtles at the House of Refuge Museum. (Ed Gluckler)*

the nest, from which hatched eighty-nine babies. During the 1960 laying season, Mr. Byrd observed another green turtle laying, but for some unknown reason, none of the eggs hatched at the Museum. Also, during the last week of September, 1960, Mrs. Helen Richards, Jensen Beach, Florida, saw a nest of hatchlings being washed out by the surf on Hutchinson Island. She was able to rescue about twenty-eight of these green turtles and deliver them to the Museum for safekeeping. From this it appears that the green turtle is native to Florida, although it has never made much of a comeback in the area after its depletion in the 1890's.

Imported Turtle Eggs

Last year the turtle enthusiasts acquired the use of an incubator and have successfully hatched several batches of eggs in the machine, along with nests planted in the sand mounds specially prepared for the eggs on the Museum's grounds. They have also imported two batches of eggs from Costa Rica through the cooperation of Dr. Archie Carr, head of the Caribbean Conservation Commission, and Professor of Biology at the University of Florida. Twenty-one babies were hatched successfully from a nest of seventy green turtle eggs on the first experiment. In 1960 two hundred live baby green turtles were received from Costa Rica to



LAWS PROTECT TURTLES *during the breeding season, but to preserve the population of these giant reptiles that are still captured in great number, it is important to safeguard the eggs and prevent damage to hatchlings as they leave the beaches. (Florida State News Bureau)*

keep in one of the tanks; these will be released later this year.

Humans Adopt Baby Turtles

Upon releasing the turtles, "HRM" (for House of Refuge Museum) and the date of release are carved on the back shell; however, the Museum is still experimenting with types of paint which will mark the shell with more visible means of lettering. It has instigated an "Adopt a Turtle Plan" for interested visitors to the Museum. For a donation of $3.00 or $5.00 the baby turtles are marked with the donor's number and left to grow in the tank until they are large enough to be released in the water. Patrons are encouraged to come to the Museum and "watch the turtles grow!" The money collected in the Adoption Program is a great asset in developing better facilities for the conservation programs.

The Museum is now including in its projects a study of the stone crabs and the Florida lobster. First attempts at keeping stone crabs with small turtles turned out disastrously for the crabs. The crabs, unlike the large blue crabs, showed no desire to bother the turtles and vice versa, until the stone crabs became vulnerable during their soft shell period. At this time, they suddenly began to disappear! Now the crabs are being kept in a small salt water aquarium until larger facilities are made available.

High School Joins In Conservation

In connection with these programs, the advanced Biology class of Martin County High School, under the supervision of their instructor, Mr. Charles Coffman, are studying the sea turtles and stone crabs. The Junior Conservation Club of Martin County has taken an active interest in the care and maintenance of the baby turtles, and one of their members, John Fox, won a prize in the recent State Science Fair for his exhibit on the feeding habits of the green turtle. These educational aspects and developing interests for research are certainly one of the most important achievements of this conservation program.

With the advent of the turtle season, State Laws now protect turtles during one vulnerable period in their lives. However, protection of turtles during the breeding season is not enough. It is far more important to safeguard the eggs and prevent damage to the hatchlings leaving the beaches. This is what the House of Refuge Museum started out to do on a small scale five years ago. With the newly increased interest, the Sea Turtle Conservation Program hopes to achieve even greater results in the future.

U.S. DESTROYER *drives through heavy seas in Japanese waters. The slow progression of a swell from a distant storm source makes possible, with more widespread weather-reporting services, a forecast of the arrival of sea surges and alleviate some of the danger and damage from the resulting high surf. (U.S. Navy)*

Devastating Sea Surges

By GENE A. RUSNAK
Institute of Marine Science, University of Miami

WITH VIRTUALLY no warning at all, freakish tides and fourteen feet high waves tore at the Atlantic beaches of Long Island and New Jersey early in June, 1960. Great areas were inundated and, when the waters retreated, they carried much sand and soil with them, leaving vistas of miniature hills and valleys along the shore. Fortunately, lifeguards were able to clear the beaches in time, so no lives were lost during this period.

Shore dwellers are not always so fortunate. Destructive, unexpected waves have not only taken a heavy toll of lives and ships on the open seas, but along the coasts as well. At one time or another, and not always during or after local storms, the margin between ocean and land in many parts of the world can expect to be hit by erratic sea surges which each

year cost lives and cause millions of dollars worth of damage.

Reports of their depredations, from yachtsmen, lighthouse keepers, fishermen and others are of increasing interest to marine scientists studying the enormous power of surf on the rampage, and the possibility of devising a means of giving adequate warning to those in its path.

Sea Surge, Sea and Swell

Although the term "sea surge" is an old and familiar one, not too much is known about them, nor their exact origins, except that they are *not* associated with local storms. Attempts to explain them as so-called "tidal waves" or tsunamis—great movements of water produced by submarine earthquakes or volcanic activity—or as the result of submarine landslides, have likewise been unsuccessful.

Since the very earliest times, winds have moved across the ocean surface, inducing the agitation of water that produces waves. Waves created locally in a storm area are called "the sea." The sea may have waves of many different sizes, moving in many directions, and often attaining considerable height in storms. As waves pass out of the immediate storm area,

IN INDIA *thousands of fishermen use light wood catamarans, but they cannot travel far or fish in bad weather. The Food and Agriculture Organization of the United Nations believes that even in poor fishing communities engines can be put into boats and more than pay for themselves in extra catches. This is one FAO prototype boat going through the surf on the Indian coast. (FAO Photo)*

however, a slower more regular pattern evolves, and the distance between successive wave crests increases.

These longer-period waves, moving away from the storm center, are known as "swell." On the open ocean, this swell can be very deceptive in its long and low profile. A passing ship scarcely notices the gradual progression from the crest of one wave to that of the next.

Waves of Distant Origin

When such a seemingly gentle swell approaches land, however, and begins to be confined vertically by a shoaling bottom, the crest can build into a wall of water and come plunging (or rolling) against the land with surprising force. Long-period "rollers" have produced breakers, reaching up to forty feet in height, along the coasts of certain islands in the South Atlantic and the Indian oceans.

The distinction between "sea" and "swell" can be drawn easily by an observer on the beach. For example, a storm in the immediate vicinity of the shore will produce a sea state of dominantly high, peaked waves. These have sharp, steep crests, spilling over into troughs and forming whitecaps far out into deep water.

If, on the other hand, the water appears to be relatively calm or to have a gently undulating swell in deep water, and, upon entering the surf zone, suddenly builds into a long, high crest, curling forward to plunge down upon the beach, then this wave is of distant origin. In fact, the swell may have travelled thousands of miles from the storm center.

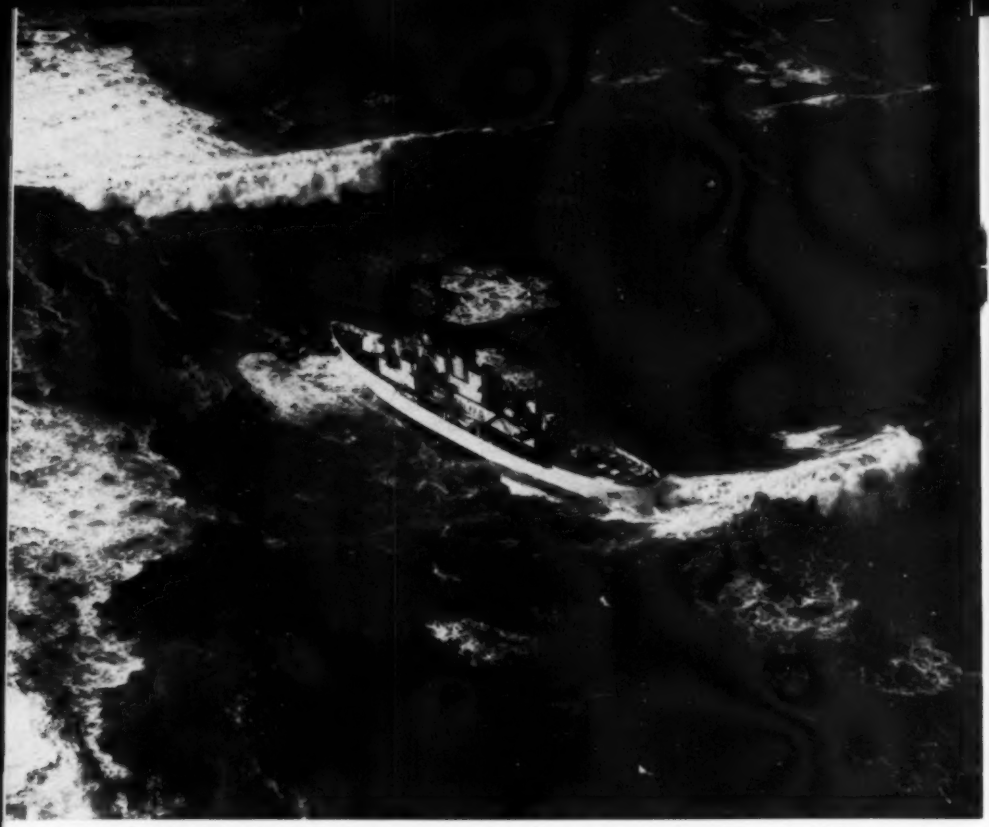
Severe atmospheric disturbances can create extremely high swell, resulting in sudden dangerous "sea surges" along distant coastlines. These may be sharply intensified if they happen to coincide with the high phase of spring tides. Warning seldom is possible, as it would be through radar or visual observations of nearby storms, or by the drop of local barometric pressure. Consequently, surges may more rightly be termed "storm swell," in reference to their origin and development at long range of the well-known big "rollers."

BEACH-SEINES *being hauled by fishermen near Jaffna. Many of the world's fishermen who now use methods like this could better feed a growing population if they were properly equipped to operate along stretches of surfbeaten coast where there are no harbors. (FAO Photo by Alan Glanville)*

Favor Western Coasts

Due to prevailing winds, large swells most often strike the western coasts of the continents. European and North African coasts, for example, receive long swells moving in from the mid-Atlantic, generated in storms of the Icelandic low pressure system. Along the coast of Morocco large rolling waves of distant origin were experienced, most vividly, by Allied landing forces during the African invasion of World War II.

The Moroccan coast is especially vulnerable because its exposed shores face directly into the path of the North Atlantic storm swell for a distance of about 500 miles. The port of Casablanca has had ships and wharves wrecked several times during periods of surge.

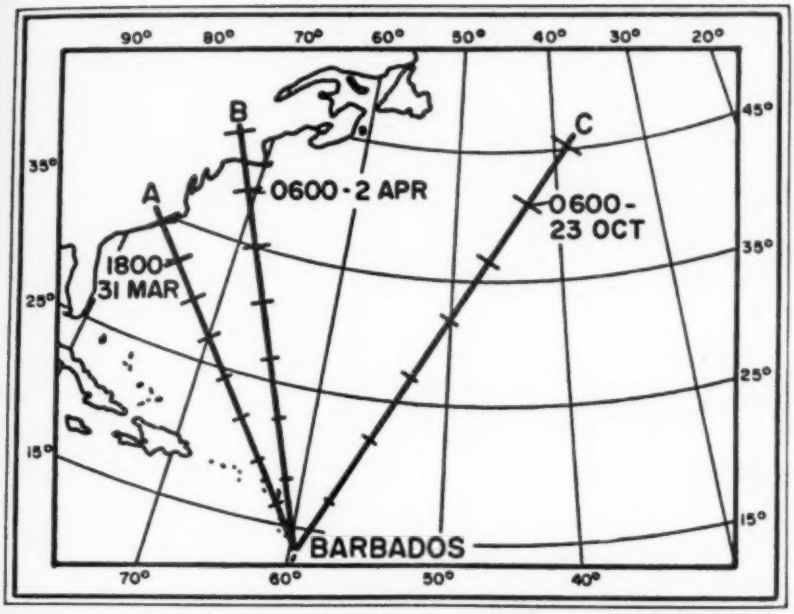


A 327-FOOT COAST GUARD CUTTER *dips into a trough between two high ocean swells as she runs to assistance off San Francisco. Due to prevailing winds, large swells most often strike the western coasts of the continents. (U.S. Navy)*

Indian Ocean "Rollers"

The eccentric "rollers" of the Indian Ocean are especially known and respected by Ceylonese fishermen, who have developed great boating skill in order to pass through the breaker zone. On the other side of the globe, swells generated in the notorious zone of the "roaring forties" are responsible for the famous heavy "surf-days" along the Pacific coast of South America. Here, seamen in the guano trade and fishermen have had their livelihood interrupted periodically as huge "rollers" battered the coast. Similar wave disturbances occur on the east coast near Rio de Janeiro, where they are known as *resacas*.

North America's west coast sometimes is hit by large swells and rolling waves approaching from either one of two directions. A winter swell arises from within storm centers near the Gulf of Alaska, where the Aleutian low pressure system prevails. During the summer months, a "southern swell" travels from within the storm belt of the southern hemisphere win-



POSITION ARCS *(Isochrones) for Barbados Storm Swell in early April (paths A and B) and late October (path C), 1958.*

ter, and occasionally dominates the Alaskan surges.

The eastern coast of North America, including the Gulf of Mexico, does not usually receive swells from distant storms, because of the prevailing wind direction. But the arc of islands along the eastern fringe of the Caribbean frequently feels the impact of distant northerly storm centers, sometimes as surf which adventurous swimmers find invigorating. In 1958 the island of Barbados twice was bombarded with sea surges which did considerable damage.

Result of Far-off Cyclone?

The Caribbean islands are protected, generally, from deep water waves by a broad shallow shelf and reefs, but coastal surge and severe surf conditions sometimes penetrate these defenses. To obtain more accurate data on the causes of such oceanic disturbances, tide gauges and wave meters were placed on Barbados, British West Indies, as a part of the International Geophysical Year program in Oceanography. The Barbados Island Observatory was installed by the Lamont Geological Observatory in cooperation with the Naval Research Laboratory. It provided valuable information on the extent and duration of sea surges in the British West Indies and established a relationship to distant mid-latitude storms.

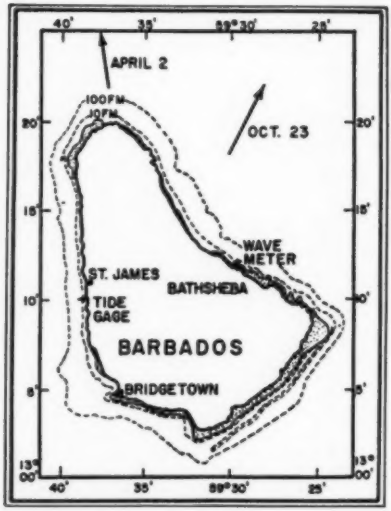
It is interesting to study the data procured during the two periods of

damaging swell and surf on Barbados. The first, April 4 to 6, 1958, affected *the entire coast* of Barbados, with greatest wave heights occurring in the early evening of April 5, some time after the first notation and warning of unusually high swell and surf.

Linked by Computation

Highest waves and the intervals between waves occurred almost simultaneously on both the east and the west shores of the island. No tropical or subtropical storms were recorded nearby, but weather charts of the North Atlantic tracked a large extratropical cyclone off Cape Hatteras on March 31, traveling northeastward during the next two days, with strong winds extending a considerable distance into the western half of storm.

ISLAND OF BARBADOS, *British West Indies. Instrument locations and directions toward storm-generating regions of North Atlantic storms (arrows) are shown.*



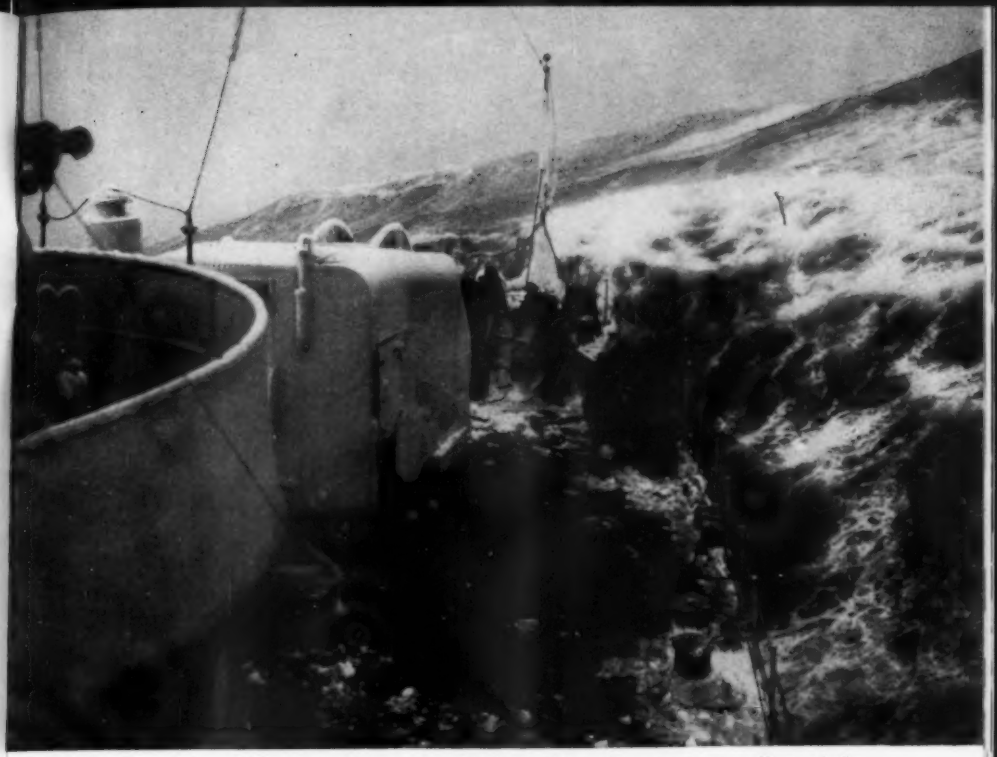
Computation of wave travel times and direction from which the swells were coming showed a good correlation with the position of the Cape Hatteras storm as it moved along its northeasterly course. The origin of storm swell and high surf observed at Barbados in April was thus attributed with confidence to this North Atlantic storm, although much more study of the problem is warranted.

The second period of observed surges struck the eastern coast of Barbados between October 24 and 28, 1958, with the highest waves during the night of 25-26, when crests of 30 feet were attained. Fishing boats were hurled onto the beaches, and sand and water washed into houses and other structures along the coastline. No tropical storms were in the vicinity, but weather charts of the North Atlantic again showed a large intense extratropical cyclone between October 22 and October 25.

Other periods of high surf occurred at Barbados May 3 through 5, 1958, and December 7 to 9, 1957. Although complete records of these surges were not obtained, weather charts showed two intense storms in the western North Atlantic immediately preceding.

Limited Forecasts Possible

Actually the slow progression of swell from a distant storm source may make possible, with more widespread weather-reporting services, a forecast of the arrival of sea surges and alleviate some of the danger and damage from the resulting high surf. The Moroccan government recognizes this fact and, as early as 1921, it established a warning service the purpose



SHIPS ON OCEAN WEATHER STATION *maintain position far at sea regardless of the weather. Here the Coast Guard Cutter* Ponchartrain *battles it out in the North Atlantic and no one aboard gets very far away from the lifeline! (U.S. Coast Guard)*

of which is to predict the state of the sea and to provide safeguards for ports along the exposed Moroccan coast. This is done through daily telegraphic reports from weather ships as well as shore stations, which give notice of approaching storm swell and enable large ships in port, if the situation looks bad enough, to find safety on the open sea.

Similarly, forecasts for the West Indies islands could be made by monitoring the regular weather reports of the North Atlantic. In this manner an alert could be issued on the approach of a storm swell, although some additional research will be needed before practical and accurate predictions can be made of the precise arrival time, with estimates of the probable height and period of the storm swell.

Oceanographers believe that modern wave-recording instruments, which can accurately locate storm centers up to 8,000 miles distant by systematic measurement of underwater pressure changes, and the accumulation of more new data will help to make possible more detailed forecasting, and can provide greater security for all shores likely to be struck by sea surge, long one of the mysteries of the sea.

The Wahoo - Nobody's Kid Brother

By E. S. IVERSEN
Institute of Marine Science, University of Miami

THERE HAS BEEN MUCH ado about catching the various spearfishes and tunas, and perhaps rightly so, because they are the big game of the deep. They give both sportsmen and scientists a real battle before they will leave their element.

Yet very little has been written about one of the toughest fish to take a bait, a fish which even experienced anglers have seldom landed—the wahoo. This may be partly because the wahoo is not a common fish, and partly because of its great strength and agility in throwing a hook. Even skilled fishermen seem to be "all thumbs" when they try to bring a wahoo to gaff.

May Reach Seven Feet

What do scientists know about the elusive wahoo and its habits? Not too much, they frankly admit. The wahoo *(Acanthocybium solandri)* can be recognized by a slender, streamlined shape; a long, low dorsal fin; sharp irregular teeth; pointed head; and, when freshly caught, by its vertical body markings. When full grown, this fish may reach seven feet in

length and weigh 130 pounds.

The wahoo, peto, ono, or queenfish, as it is variously known, dwells only in tropical and subtropical waters. In a few parts of the world, including Japan, Hawaii and certain parts of the Caribbean, it shows up as a food fish in the market. While a native of Florida waters, less than one per cent of all sport fish landed in Florida is wahoo, and there is no commercial production. But fishermen like wahoo for its power and speed, and it poses some challenging questions for biologists.

Shallow and Deep Feeders

If you want to catch one, wahoo favors rubber squid and feather jigs, used in surface fishing. When a wahoo strikes a trolling line, the angler is sure to know it! However, some wahoo caught for the Japanese and Hawaiian markets are taken on longline (flagline) gear, fishing at depths of about 200 to 600 feet.

Longline consists of a free-floating long main line, from which are suspended hooked branch lines, baited with frozen sardines or herrings. Although the bait hangs relatively motionless, it somehow appeals to the wahoo. Catches by these different gears give biologists some insight into the distribution of this powerful swimmer. Many more wahoo are caught close to land than in the open sea, and more are caught close to the surface than at depths. As a rule, they travel in loose schools.

Six Million Eggs

Like many fish of the warm seas, some wahoo spawn throughout the year, liberating free in the water more than six million eggs at one time. The young are not provided with the relative luxury and protection of a nursery area, such as mangrove swamps, as are many other tropical and subtropical fishes, but must brave the open sea from the time they are hatched. Mortality is truly enormous.

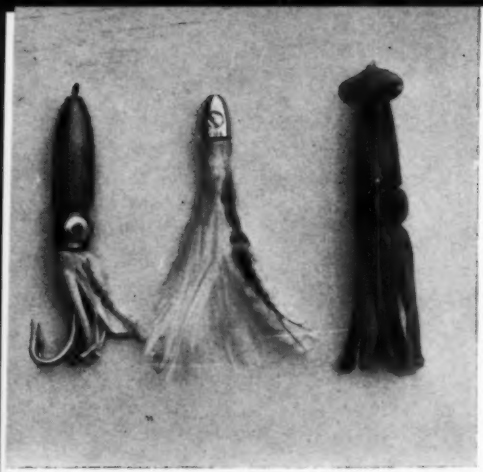
The early development and growth of the wahoo is still unknown in scientific literature — another of those large marine areas awaiting investigation and field research.

Victims' Heart Beating — In Wahoo Stomach

Biologists trying to investigate the wahoo diet find it difficult to obtain wahoo with full stomachs. In the struggle to free itself from the hook, the temperamental wahoo often disgorges its entire stomach contents. In cases where the stomach contents were intact, a small mackerel-scad was found, in neat chunks. The hearts of these fish were still beating in freshly-caught wahoo! They also eat tuna, squid, and even puffers.

Wahoo fits the description of fishes poisonous to man, because most species causing fish-poisoning (ciguatera) in humans are also fish-eating shore fish that live near reefs. Nevertheless, there is no record of poisoning by wahoo.

TROPHIES OF THE SEA. *This is but part of a fourteen-wahoo catch in Bermuda. One, lower center, is little more than a head. Its body was probably consumed by a predacious shark or barracuda as it was being brought to gaff. Note vertical body markings — visible only on freshly-caught wahoo. (Bermuda News Bureau)*



THREE EFFECTIVE *lures used in trolling. Wahoo favor rubber squid and feather jigs, used in surface fishing. However, some wahoo are caught for the Japanese and Hawaiian markets on longline gear at depths from 200 to 600 feet. Hooks are baited with frozen herring or sardines. (U.S. Fish & Wildlife Service)*

Free-Loaders and Hitch-Hikers

Practically every marine fish has its share of parasites and the wahoo is no exception. Commonly, two worms (trematodes) of large size are found. And beware of their bite! In one instance, when a worm was pulled free of the stomach wall, it sank its "teeth" into a biologist's finger so tightly that it could be justled up and down like a small yo-yo, its neck contracting and expanding rhythmically.

In the hollow of a joint of the pectoral fin lives another parasite whose number is limited, perhaps, by what the traffic will bear. Two copepods (Crustacea) can be found in this joint on each side of the fish. The small, unwelcome guests, which feed on the host's flesh, are well-protected when the fish is swimming rapidly; the pectoral fins fit tightly against the body and the copepods are held snug inside.

Some wahoo carry an odd-shaped small copepod which buries its head in the fish's body wall, with only its posterior exposed. The tail end looks like a small shaving brush and the head end is shaped like an arrow head. They are attached so securely that attempts to extract them by force result in the copepod's body tearing free from its head. There are other less spectacular parasites in the wahoo, but none is harmful to humans.

Invitation to a Marine Biologist

Few biological studies of the wahoo have been made, but not because it is uninteresting. The few references concerning wahoo in scientific literature reflect the inability of biologists to collect sufficient samples to draw conclusions.

Many problems can be listed: For instance, how old do these fish get? No one knows. Are wahoo ever dependent upon inshore areas for their existence?

What is the significance of the geographic distribution of wahoo? Are those found in the open sea stragglers that have lost contact with land, or are there regular inter-island migrations? What is the meaning of the marked differences in both the ratios of males to females, and in the sizes of wahoo with latitude observed in the central Pacific?

Clearly, this relative of the popular tuna is "nobody's kid brother." It is obvious that the wahoo has failed to receive the scientific study and angler's attention it rightly deserves.

NEW HEADQUARTERS *of the Marine Laboratory of the University College of the West Indies, Jamaica, well situated on a peninsula between Kingston harbor and the Caribbean. The laboratory is supplied with running sea water, air-conditioned research rooms, a storehouse and workshop. A dock gives ready access to the water. (University College of the West Indies)*

Jamaica's Marine Laboratory

By D. M. STEVEN

Professor of Zoology
University College of the West Indies

ALTHOUGH IT IS rather small compared with some major marine laboratories in the United States and Europe, the marine laboratory of the University College of the West Indies has a research program which compares in variety and scope with stations many times its size and age.

Founded in 1956, as a section of the Zoology Department, by which it is still administered, Jamaica's representative in the rapidly-growing world family of oceanic research institutions has recently moved to a new building, not far from its original rented quarters in the old British naval dockyard, Port Royal, near the tip of the Palisadoes peninsula that shelters Kingston harbor. Its historic site is already famous in the annals

of the sea. Here Horatio Nelson served as a young lieutenant in the Royal Navy, and earlier still it was the stronghold of buccaneers led by Henry Morgan, "the scourge of the Spanish Main."

Sea Water Benches

The new laboratory consists of a large aquarium room, generously supplied with running sea water, and a large veranda also equipped with sea water benches. In addition, there are two air-conditioned research rooms, a store and a workshop. As yet, there is no dormitory, but visiting scientists may stay at a nearby beach club, or they can drive out daily from Kingston in about half an hour.

Oceanic field equipment includes the 26-foot launch *Pelagia,* a sturdy general purpose day boat, with a running sea water storage tank for live collections, and three smaller boats useful for work in the harbor. Aqualungs and a good variety of collecting gear also are available for research work.

Great Variety of Marine Life

The beautiful blue-green waters of the Caribbean off Port Royal offer practically ideal conditions for the study of tropical marine biology,

HEAVILY ENCRUSTED *with marine growth, two boards are lifted from the water. These will be taken to the new laboratory for study. Specimens of many unusual sea creatures can be collected in quantity in Jamaican waters and brought alive to the laboratory within a short time. (University College of the West Indies)*

owing to fine weather conditions and the great variety of sea plant and animal communities within easy access. On the other or land side of the Palisadoes, Kingston's vast harbor offers several miles of enclosed waters with different types of soft bottoms and large shallow areas. The latter, covered with turtle grass, shelter a rich invertebrate and fish fauna. Extensive mangrove swamps, lagoons and salinas, as well as two small river estuaries, offer still further happy hunting grounds for marine researchers.

But the most important work probably will be done outside the harbor, in the shallow sea area that spreads south for several miles. Here a complex system of coral reefs and sandy cays, interspersed with shallow lagoons and deeper channels, offers some protection from heavy waves, permitting investigations at varying depths. Beyond the barrier reefs, the floor of the Caribbean drops precipitously to oceanic deeps. Soundings of 500 fathoms (3,000 feet) and more can be attained in less than an hour's sailing time from Port Royal.

Bring Them Back Alive

For students of ecology, or the mutual relationships between marine life and its environment, this is a rewarding place. Not only is there rich variety of flora and fauna, but of the forty odd species of coral known to occur in Jamaican waters, over thirty are found off Port Royal. Sea feathers and sea fans are very common, while the sponge, shell, shrimp and crab faunas are rich in species, and by no means completely known. There are at least ten common species of sea urchins, some of which can be collected in unlimited quantities, as well as twenty species of sea squirts.

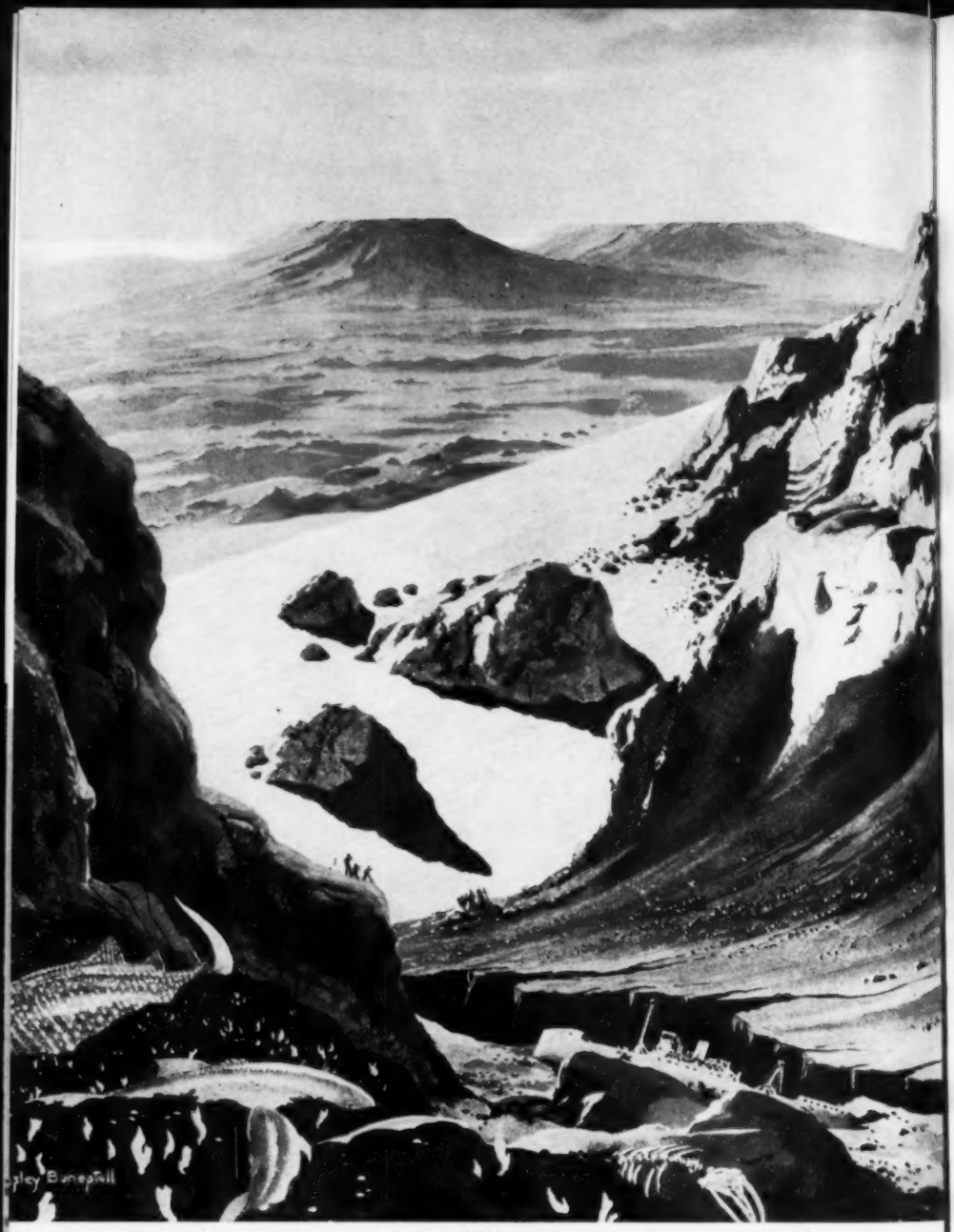
Two rarities are the sea lily *Nemaster,* and the jellyfish *Carybdaea.* Kingston Harbour is one of the few places they are found.

Schooling Behavior of Fish

Members of the College staff have been engaged in a variety of interesting studies during the past few years. These include the schooling behavior of fish, the biology of *Ascidia nigra* (black sea squirt), the development of sessile marine communities, the physiology of reef-building corals, the structure of Jamaican coral reefs and the ecology of shallow water sponges.

Visiting scientists have worked on the neurophysiology of *Cassiopaea* and other jellyfish, the development of sea squirt larvae, the parasites of various invertebrates, and the pigments of sea feathers and sea fans. The possibilities for the study of many aspects of the reproduction and development of many marine creatures are especially attractive in Jamaican waters, since with the constant high-water temperatures, many animals breed throughout the year.

The marine laboratory can now be considered a well established part of the University College of the West Indies, and it offers its excellent facilities for a wide variety of marine research. Intending visitors should write to the Professor of Zoology, University College of the West Indies, Mona, Jamaica.



THE PRIMEVAL SPLENDOR *of these Mid-Pacific Ocean Mountains is seldom witnessed by man. The majestic underwater world has been portrayed here by artist Chesley Bonestell. (Courtesy Edwin L. Hamilton)*

The Floor of the Ocean

By C. P. IDYLL

EDITOR'S NOTE: This article is based on a chapter from a book to be published later this year by the Thomas Y. Crowell Company of New York. It is published here with the kind permission of the editors of that company. Tentatively entitled *The Deep Sea*, the book describes the origin of the ocean and the character of the deep sea, as well as the interesting—sometimes incredible—creatures that inhabit it. *Sea Frontiers* will feature additional parts of this book in forthcoming issues.

"The floor of the ocean" is a misleading phrase since it implies something flat and featureless. Nothing could be further from the truth. The sea floor has far more ups and downs than the land and, because it lacks the eroding forces of running water and wind-driven sand which level the land, its relief is much more rugged. Beneath the sea there are peaks higher than Everest, mountain ranges longer than the Andes or the Alps, and gorges seven times deeper than the Grand Canyon of the Colorado.

Except for a few islands poking above the surface, the ocean landscape is hidden from human view. Over seven tenths of the planet we live on is unknown to us, except indirectly through soundings and a very few photographs. The face of the moon, 239,000 miles away, is like a map of our home town, while our "back yard," the bottom of the ocean, remains largely a mystery.

Half Drowned Planet

Water that hides seven tenths of the earth makes it possible for us to live on the remaining three tenths, while the absence of liquid water on any of the other heavenly bodies within our ken makes it extremely unlikely that life exists on them. But the land on our planet that gives much of this life a foothold is very unevenly distributed. This is fortunate for us, for if the earth were smoothed out and became a perfect sphere the oceans would be a uniform 8,000 feet deep over the entire globe, and fishes would rule the world.

How did the continents assume their present shape, and why do they occupy the positions that have been debated heatedly for centuries? Since about the beginning of this century it has been a favorite game to fit the jig-saw puzzle together and to speculate whether all the land masses were once joined where the Atlantic now rolls. During some monstrous cataclysm, it is visualized, this super-continent cracked apart and the two halves began to drift away from each other.

Lost Continent of Atlantis

Certainly the main bulges of the land on the western edges of the Atlantic Ocean appear to fit neatly enough into the principal indentation of the eastern edge, and vice versa. Sometimes this theory includes fanciful ideas of pieces of the continent being left in mid-ocean long enough for humans to inhabit them, and then sinking beneath the surface. "The Lost Continent of Atlantis" has been a favorite theme of novelists, and

writers for Sunday supplements. Unfortunately for the romantic idea of ancient cultures trapped beneath the sea, Atlantis and its companion "continents" are regarded as fairy tales by most scientists since geologists say this part of the sea bottom has not been above water for millions of years.

The great submerged flats of the continental shelves, which usually are about 600 feet deep where they meet the continental slopes, are very important to the economy of the sea since it is in their shallow, sunlit waters that most of the life of the sea is concentrated, and hence where most of the fish and other useful creatures are caught.

The transition from the continental shelf to the deep sea is abrupt. At roughly 600 feet deep the face of the earth suddenly plunges into the abyss, down to depths of 10,000, 20,000 and even 30,000 feet. Anyone who has peered over the cliff at Glacier Point at Yosemite National Park, into the heart-stopping depth there, will appreciate these enormous drops, because the distance from mountain top to valley floor at Yosemite is only 3,254 feet compared to the many thousands of feet in some places in the sea. No continental mountain plunges so far and no escarpment on land is as long as some in the sea, which may stretch for hundreds of miles in an unbroken and stupendous cliff.

Most of Earth Submerged Two Miles

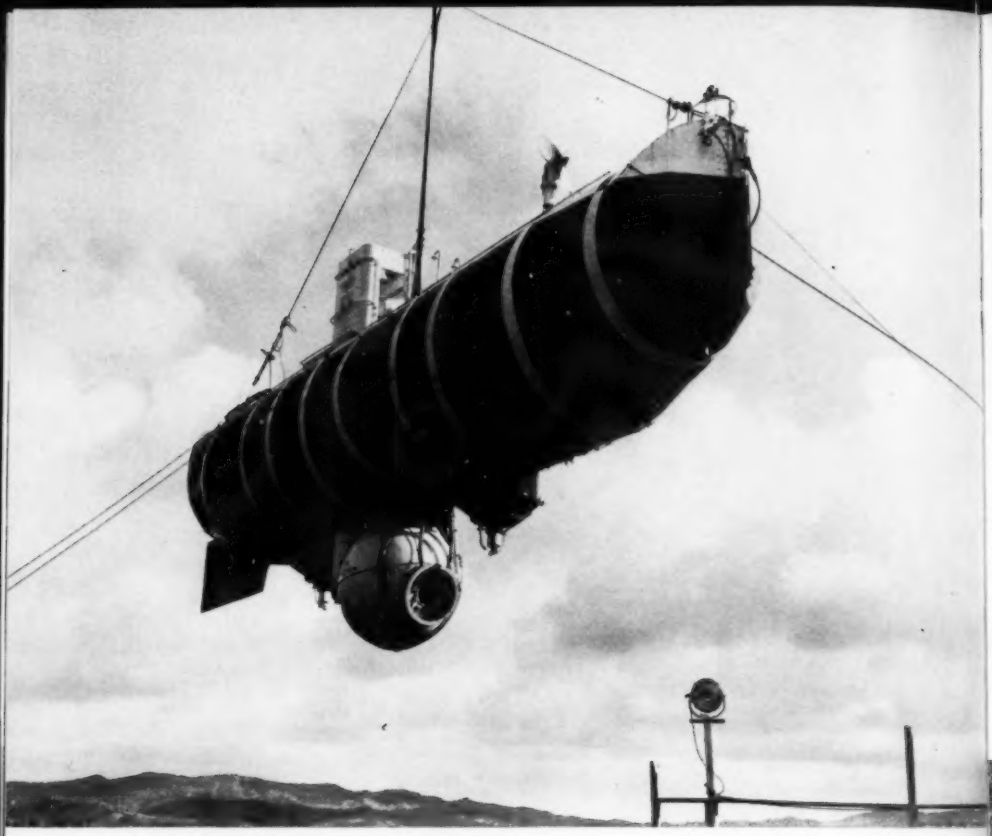
The shallow lighted areas of the sea have claimed the attention of man far beyond their relative size. Actually the shelf areas of the world constitute a small three per cent of the total area covered by the oceans. The deep regions, almost completely unexplored and unseen, cover by far the greatest area of the globe, and very deep waters constitute much more than half. In fact, four fifths of the oceans are almost two miles deep, and the average depth of all the oceans is a tremendous 12,468 feet. By contrast the average height of the land is only 2,756 feet above sea level. Hence, as we leave the shelf and plunge down the continental slope into the deep sea, we are approaching by far the commonest features of the world.

Most of the great deeps of the ocean are in the Pacific. The principal trenches are the Aleutian, Kurile, Japan, Marianas, Tonga, Philippines, and Java Trenches. Until a few years ago it was thought that the Mindanao, or Philippines Trench, was the deepest, but its 34,428 feet is now known to be exceeded by two other vast furrows.

Bathyscaphe Probes the Deeps

A vivid illustration of the rapidity with which oceanographic information is being gathered and corrected is that the recorded depth of the deepest part of the ocean, in the Marianas or Challenger Deep, has been altered several times in very recent years. In 1951 it was stated as 35,640 feet; in the summer of 1959 the Russian oceanographic research vessel *Vitiaz* reported a depth of 36,200 feet. Then, on January 23, 1960, the U. S. Navy's bathyscaphe *Trieste* carried two latter-day explor-

MOST OCEAN DEPTHS *are more than 9,000 feet (areas shown in white on the map), with relatively few "shallow" areas less than 9,000 feet (shown as stippled portions). Mid ocean ridges (shown as heavy black lines) are as prevalent under oceans as mountains are on land.*



U. S. NAVY'S BATHYSCAPHE TRIESTE *on January 23, 1960, carried two latter-day explorers to a depth of 35,800 feet in the Marianas Trench. This is now regarded as the most accurate recorded depth of the deepest part of the ocean. (U. S. Navy)*

ers to a depth of 35,800 feet in the deepest part of the trench, and this is now regarded as the most accurate figure to date. The Tonga Trench, as measured by the Scripp's Institution vessel *Horizon,* is 34,860 feet deep and takes second prize for maximum depth. Some of the deep trenches are remarkably long, up to 2,000 miles along the ocean floor.

In the Atlantic the deepest trench is the Puerto Rican, to the north of the island, and its depth has been recorded as 28,708 feet. The Romanche Trench and the Cayman Trench are other notable deeps in the Atlantic, while only one in the same order of magnitude occurs in the Indian Ocean, this being the Sunda Trench.

Mount Everest Lost in the Ocean

Mount Everest, 29,002 feet in height, would be drowned beneath well over a mile of water if it were dropped in the Challenger Deep. It may further hurt the pride of earthlings to know that several mountains beneath the sea are higher than Ev-

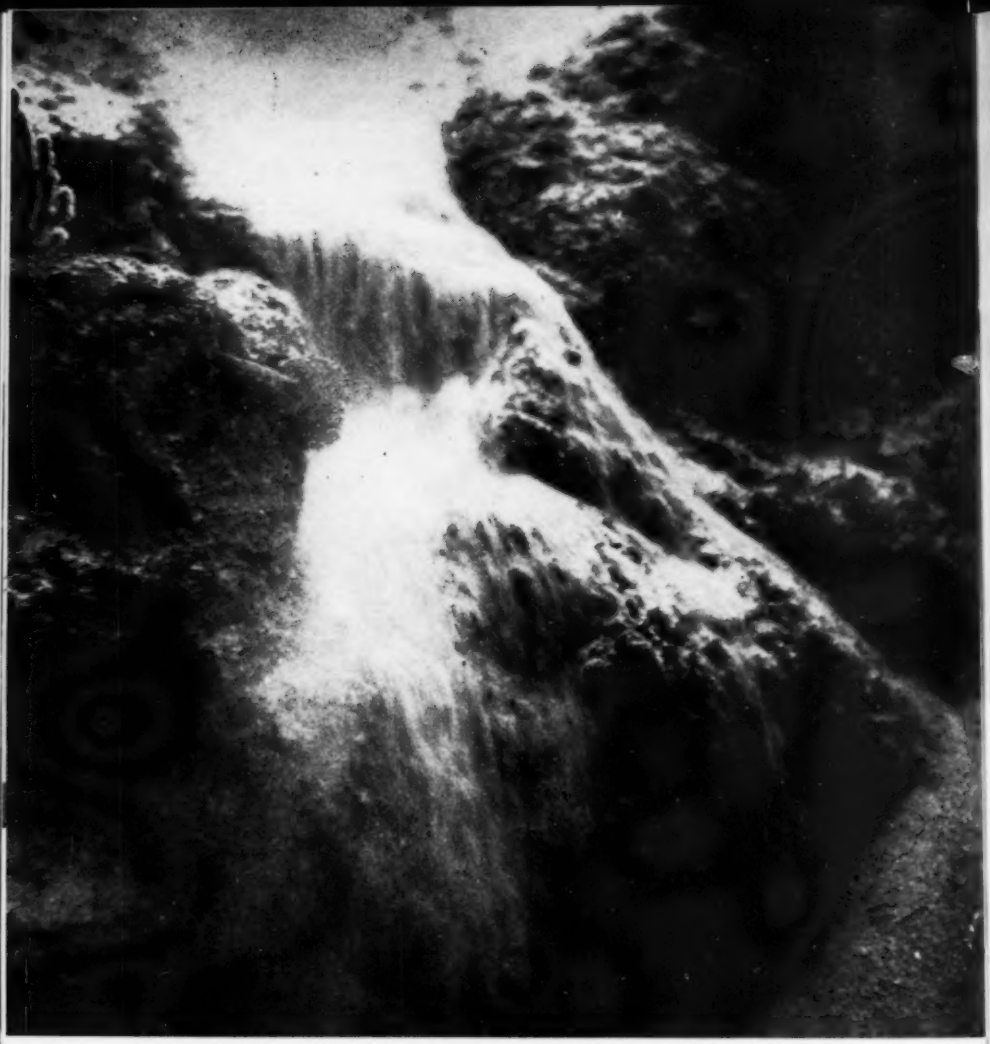
erest. The greatest peak on earth is Mauna Kea, in the Hawaiian Islands, which soars 31,000 feet from the ocean bed to its top, the last 13,823 feet of the mountain emerging from the water.

It was dimly realized a century or more ago that mountain ranges existed in the middle of ocean basins, and that mid-ocean islands were peaks of some of these mountains thrusting above the waves. Then as more soundings were taken the extent of these ranges became clearer, and it was found that they were not isolated ridges, but major features of the earth's crust.

The Mid-Atlantic Ridge, first mapped during the laying of the trans-Atlantic cable, twists down the center of the ocean for over 10,000 miles, from Iceland to Tristan da Cunha. This enormous mountain range is broken only once, by the Romanche Trench near the equator. Most of its peaks are drowned beneath thousands of feet of water, but a few are high enough to break through the surface of the lonely Atlantic and become familiar to man as mid-ocean islands: the Azores, Ascension Island, the Rocks of St. Peter and St. Paul.

A mid-Pacific Ridge exists also, but on a smaller scale. This mountain range divides the Pacific into basins, and its peaks form such island groups as the Hawaiian Islands, the Mar-

PHOTOGRAPH OF THE DEEPSEA BOTTOM, *on the Mid-Atlantic Ridge, at a depth of 11,200 feet. A compass is shown at the end of a hose and wire from the ship. Woods Hole Oceanographic Institution.*



A "SANDFALL" *in the Cape San Lucas submarine canyon, Baja California. The fall is about thirty feet high and currents feed sand from the nearby beaches into the canyon. (Conrad Limbaugh, University of California, Scripps Institution of Oceanography)*

shalls (which are the tops of high volcanoes), the Tonga Islands and many more.

Discovery of World-Wide Undersea Mountain Chains

It was only in the International Geophysical Year, in 1957, that the true magnitude of the mid-ocean ridges became clear. The upsurge in ocean exploration stimulated by that activity showed that not only were the ridges in all the oceans much more immense in size than had been suspected, but that they were all

connected, and that in fact there is one long, virtually unbroken ocean mountain system over the entire globe.

Mystery of Flat-top Mountains

The origin and age of the mid-ocean mountain ranges do not present the only intriguing mysteries concerned with sunken peaks. Some of these have their tops neatly sliced off. These strange flat-topped mountains were discovered by a Princeton University oceanographer, Harry Hess, during World War II when the naval vessel on which he was serving as navigating officer recorded one of them on its echo sounder. He was astounded at the flatness of the peak, and took pains to examine echo traces of the Pacific underwater landscape at every opportunity. Before long he had mapped 19 flat-topped peaks, which were named "guyots," and subsequently many more were discovered.

The shape of the guyots is only a small part of their strangeness. Rather it is the implication of this shape, since the peaks of the mountains could only have been planed off by erosion if the mountains once stood above the ocean's surface. But many of these mountain tops now stand 6,000 feet below the surface. There is no doubt that they are ancient drowned islands, since dredging on their tops brings up rounded pebbles and boulders, similar to those produced by the surf on shallow beaches, sandstone compacted from ancient beaches, and reef corals which grow only in shallow waters. The exciting conclusion arrived at from studies of this material is that a great range of island mountains existed in the Pacific during the Cretaceous Age—the time of dinosaurs.

Lost Land of Pacific Discovered

But now arises the mystery. Did the sea rise the mile or more necessary to cover the guyots, or did the crust of the earth bend downward that distance? Or both? It seems likely that after the waves had planed off the soft volcanic rock at the surface of these volcanoes, the weight of the newly born mountains was too much for the crust of the earth to bear, and whole regions gradually sank beneath the waves. At first the rate of sinking was slow and the reef corals were able to keep pace with their growth; later the islands sank too fast and the corals were killed.

Hence, a great range of mountains, the "Mid-Pacific Mountains," whose peaks stood proudly above the sea from Hawaii nearly to Wake Island, lies beneath the ocean — an honest-to-goodness sunken landscape. Some of the islands which avoided a watery death exhibit clearly the effect of their immense weight on the crust of the earth. Hawaii sits in a very distinct depression in the floor of the ocean, its own massive bulk bowing down old Mother Earth. Perhaps in a few millenia the Fiftieth State may sink gently below the waves, and a genuine "Lost Pacifica" will join a legendary Lost Atlantis.

Catamaran Comment

Dr. F. F. Koczy's interesting article, "Catamaran, New Concept in Research Vessels," which appeared in the February issue of *Sea Frontiers,* has prompted comment from Robert Sutherland, Jr. of Bridgeport, Connecticut.

Mr. Sutherland, a naval architect, writes: "I have wondered if Dr. Koczy is aware how closely the dimensions of the proposed ship correspond to those of *Demologos* (or *Fulton the First*), also a catamaran design, the first steam warship of any Navy.

"Designed by Robert Fulton, *Demologos* was built in New York and launched in October, 1814, a little over 147 years ago. At the time of her launch, she was by far the largest steam vessel yet built, by hundreds of tons displacement.

"Dr. Koczy wrote of the late-19th century catamaran channel steamers, and states in his article that 'All the other catamarans were a maximum of 100 feet long.' *Demologos* was earlier, and over 100 feet long. I do not have their dimensions, but it is possible that the four or more double-hulled sailing vessels built in England during the reign of King Charles II, or the double-hull gunboats built in England near the end of the 18th century, were also over 100 feet in length.

"If you are interested in a shallow draft but seaworthy craft with immense deck area and the ultimate in stability, have some research done on the 'popoffkas' built in Russia during the 1870's and 1880's and more or less laughed out of existence by hidebound conservatives, though they were praised by a few brilliant designers and outstanding seamen. I have read several professional papers on the popoffkas, and predict that we will build them soon again for special purposes — like oceanographic research.

"As an example of a popoffka, I cite the *Livadia,* built in 1880 as the Imperial Russian Yacht. She was approximately 230 feet long by 153 feet beam by 7 feet draft, displacing 4720 tons. On trials she made 12.5 knots on 4500 indicated horsepower, and reached a top speed of almost 16 knots with about 12,000 IHP. Triple-screwed, she handled very well at sea. In a severe storm in the Bay of Biscay, in 25′ waves, she never rolled more than 4 degrees to a side."

Real Low Down Coral Reef

Strange as it may seem, one of the world's largest caves was once a coral reef, buried in ancient times. Flowing water dissolved the limestone of the reef, hollowing out Carlsbad Caverns, famous National Park in New Mexico.

SHRIMP FLEETS *in the Gulf of Mexico and South Atlantic shrimp fisheries discard millions of pounds of trash fish annually. The proportion of scrap fish to usable shrimp varies according to location and time of year, but Miami scientists have found ratios as high as thirty-to-one pounds of scrap fish to shrimp. (South Carolina State Development Board)*

Don't Call Them Trash Fish

By WILLIAM SAENZ AND GARDNER SOULE

SOMETIMES THE GREAT bulk of a commercial fisherman's catch consists of so-called trash fish — fish considered so worthless that they are thrown back into the sea. Trash fish may be many times the weight of the edible catch and in some cases constitute a hindrance to the fishing operations. In the Gulf of Mexico and South Atlantic shrimp fisheries, millions of pounds of trash fish are discarded annually.

But hold on there, skipper! These "worthless" fish may soon develop a commercial use and so change from a nuisance to a potentially usable raw material. This could make a big difference in the income of fishermen. The hopes of reclaiming and utilizing waste fish are based on a process that is made possible by the activity of substances called enzymes, which are naturally present in the fish. These chemicals are found in all living or-

ganisms. They play a multitude of important roles and are intimately related to the very living process itself. Man has isolated many natural enzymes and has put them to work in a number of industrial processes — the conversion of starch into sugar and brewing meat tenderizers to name two.

The action of enzymes is not completely unfamiliar to us; in fact, we are surrounded by and ever dependent on their activity. They constantly build and tear down all biological materials. The so-called gastric juice is a concentrate of various enzymes which are largely responsible for the breakdown of proteins and the liquefaction of food in the human stomach.

Do not let the diminutive size of enzymes fool you! Even though they cannot be seen under the most powerful microscope, their effects are in every respect formidable. When protein-digesting enzymes act on a fish, they liquefy the flesh in one or two days. A moderate temperature such as that of the human body — about 98 degrees — is necessary for the chemical action to occur. To accomplish the same work in a laboratory, a chemist would require a powerful

ENZYMES—*chemicals derived from living matter—can remove guts and scales from waste fish. Here Dr. W. W. Meinke, head of the Chemurgic Laboratory, Texas A. & M., examines a small fish that has been eviscerated by an enzyme solution. (Texas A. & M.)*

acid and sufficient heat to raise the temperature above the boiling point of water; the process would probably take twenty-four to thirty hours.

Digestion in its Own Juice

The powerful digestive enzymes of the fish act on its own flesh and convert it to "liquid fish." This process normally goes on uncontrolled as the fish comes out of the water. Associated with this action are other changes, mainly caused by microbes and resulting in offensive odors typical of decaying and putrid fish.

A process investigated at The Institute of Marine Science at the University of Miami draws upon this fantastic ability of enzymes to break down proteins to liquid by-products at ordinary temperatures. In order to keep the "digestion" orderly and prevent bacterial decomposition, acid is added. This procedure sets up conditions in this system that are similar to those found in the stomachs of fish and other higher animals.

Let Enzymes Do the Work

A feature of the process which is attractive to fishermen and businessmen is the low labor and equipment cost. Chemists call the enzymes "catalysts," because they promote a chemical action when the conditions are right. In this case, once the stage is set the show goes on without outside help.

Occasional shaking of the container is helpful and so is a moderate temperature of about 100 degrees. Both of these conditions are available to the fisherman at no cost or effort. The rolling of the boat provides the necessary agitation and the sun the required heat. Even the heat can be increased by simply painting the containers black.

FISH EVISCERATED *by enzyme solution. Even though enzymes cannot be seen under the most powerful microscope, their effects are formidable, and their fantastic ability to break down proteins to liquid by-products at ordinary temperatures holds the key to important trash fish research. (Texas A. & M.)*

One decided advantage of the enzymatic digestion process is that quantities as small or as large as the capacity of available tanks can be processed. Other methods used to transform fish into industrial products require a fixed amount of fish, generally a large quantity which depends on a steady high production. In order to handle and transport large quantities of industrial fish at sea, complex and expensive gear is needed. Such equipment is therefore not suitable for handling "trash fish" which, although great in total, are distributed in relatively small amounts among many boats in a large area. The alternative of collecting the fish at a

FISH SOLUBLES *find a ready market with producers of poultry foods. Their use in poultry ration over the past ten years has constituted one of the biggest advances in poultry feeding in the United States. (Florida Agricultural Experiment Station)*

central point is not practical, for it would require holding the fish in ice or refrigeration, a practice that is prohibitive when one is concerned with a low-price commodity.

Highly Nutritious By-products

The whole liquid fish contains all the basic nutrients found in fresh fish. In contrast to available commercial products, fish meal and solubles retain intact the heat-sensitive nutrients that are lost through present methods of manufacturing. Partially solubilized proteins have been used in medicine to treat infants, the elderly, and convalescents having impaired digestion.

Several products from liquid fish have been investigated and many more have been proposed. The clear liquid that separates during digestion is rich in peptides and amino acids, the building blocks of all proteins and essential compounds in human and animal nutrition. This fraction could be used as a nutrition booster for enriching certain "incomplete" foods. An example of this fortification is the addition of the amino acid lysine to bread and cereals. When concentrated, this liquid fraction converts into a sirupy or dry material similar to boullion cubes. Similar products—for instance the fish sauces from the orient such as NUOC-MAN from Indonesia—are well-established savory condiments among gourmets.

One everyday example of the use of hydrolyzed proteins in seasoning is soy sauce.

Another attractive possibility for the utilization of this fraction is in the manufacture of biochemicals for laboratory and industrial uses. For instance, it could be used as a growing medium for the culture of antibiotic-producing microorganisms. Admittedly, this would be a comparatively low-volume outlet, but some of the products which could be extracted demand a very handsome price.

The raw liquid fish, which includes the liquid and non-digested solids, has been dried to prepare a fish meal suitable for animal feeding. A somewhat more prosaic application occurs in the fertilizer industry. Liquid fish can be used as the starting material for the compounding of liquid fertilizers, plant starters, and other related products. The availability of organic nitrogenous materials and minerals in the fish makes it a valuable constituent of fertilizers. Some investigators have reported that, in addition, liquid fish fertilizers have a beneficial effect on the mechanical characteristics of the soil.

What it Means to the Fisherman

Shrimp fishermen have been experiencing difficult financial times during the past few years. Undoubtedly many factors have conspired to create this situation, but one frequently given as the most significant is the increase in the number of fishing vessels in recent years. The utilization of trash fish could provide the shot-in-the-arm needed by some of the marginal operations. At present, the trash fish is discarded. The proportion of scrap fish to usable shrimp varies according to the location and the time of the year. Miami scientists have surveyed the production of scrap fish, finding ratios of from two-to-one to thirty-to-one pounds of scrap fish to shrimp.

Close estimation of the production costs cannot be made until somewhat more concrete plans are formulated for the utilization of scrap fish. Manufacturing costs are extremely low, since five pounds of sulfuric acid will acidify one hundred pounds of fish. The cost of this chemical is about $3.15 per ton of fish.

Investigations of Other Laboratories

Scientists at Texas A & M Engineering Experimental Station have reported on a process that uses a special enzyme solution to digest viscera, bones, and scales in fish. The

TYPICAL GULF OF MEXICO HAUL *consists largely of trash fish, hitherto useless but now of great possible service to man. (Texas A. & M.)*

process has been patented and users must pay a royalty, but even then it is reported that a profit could be made. The reports indicate that one ton of mullet processed and deheaded leaves 850 pounds of carcasses. Solubles from the digest give 316 pounds; bones and scales represent 157 pounds, and oil about thirty pounds.

Fish solubles have a ready market with producers of poultry foods and are valued at $60 to $100 a ton. Their use in poultry ration over the past ten years has been one of the biggest advances in poultry feeding in the United States.

Dr. Meinke of Texas A & M is able to apply his process at a cost of $27.86 a ton to make products worth $36.76 a ton. So far he has worked mostly on Gulf of Mexico species such as golden croaker and sand trout, but he believes the method can be applied to most species of trash fish.

The large number of inquiries received by the Institute of Marine Science at Miami regarding utilization of trash fish indicates a widespread interest. The self-liquefying process used at Miami and the special enzyme solution method developed at Texas may well result in substantially greater yields of food from the sea—yields important in a world in which the population has already expanded faster than the ability to feed it.

Science! Not Sorcery . . .

Scientists can determine the temperatures that prevailed in oceans hundreds of thousands of years ago! This apparent sorcery is accomplished by measuring the amount of oxygen-18 stored in fossil shells formed in the deep sea sediments covering the ocean floor. The percentage of the isotope in a shell varies according to the chilliness or warmth of the sea surface at the time the shell died and sank to the bottom. The age of the shell is determined by radioactive measurements.

Harrowing Experience!

Drills and starfish, chief enemies of the oyster, are undergoing an agricultural experience in certain Chesapeake Bay areas. An oyster company is using a harrow to bury and destroy them — a pilot study being done under a contract with the Bureau of Commercial Fisheries. According to recent reports both drills and starfish were killed when covered by about one inch of bottom material turned over with a harrow. Scuba divers were used to check the results. Tank studies showed further that when only one or two of the starfish's rays were covered, 80% of the creatures died.

New Lifeboats

The Coast Guard's famous 36-foot motor lifeboats, in use since 1929, will be replaced at the rate of ten a year by new 44-footers, designed to keep ahead of the pleasure-boat boom of recent years. The first of the faster all weather craft is scheduled for completion late in 1961.

Want To Go Beachcombing?

North Carolina's Outer Banks are among the farthest "at sea" parts of the U. S. mainland. They were formed by a struggle between the Gulf Stream and the Atlantic Ocean, with the wind as a referee. Along their treacherous shoals, during the past 400 years, more than 2,200 craft have met doom. So beachcombing, or collecting of relics washed in by the waves and tide, is a prime attraction. To maintain the natural beauty of this stretch of warring waters and rugged dunes, the National Park Service has dedicated an eighty-mile stretch of shoreland as the Cape Hatteras National Seashore Recreational Area. Here beachcombers may salvage anything they find, from a pulley block to a weathered nameboard, or perhaps gnarled bits of driftwood, carved into fantastic shapes by driven sand.

Fish versus Outboards

Scientific surveys indicate that our fish are safe! Professor Carl Lagler and associates of the Department of Zoology of the University of Michigan have recently conducted a study to determine whether the use of outboard motors adversely affects fish in any respect. Therefore, any possibility of effect on aquatic vegetation and on the oxygen and impurity content of the water itself had to be explored. The potential polluting agent, it was thought, would be oil, fuel and exhaust gases discharged into the water by the increasing number of motors.

In the three motor-use ponds examined, no indications of oil pollution could be discovered. "It did not appear on marginal or aquatic vegetation, on the many clear pine test strips set in the water near the shore, or on the concrete structures for control of pond levels." Since no fuel pollution could be discerned in these experimental ponds, it is generally accepted that outboard motors do not have any great adverse effects upon aquatic life.

Louis R. Wasey

The death in August of Louis R. Wasey, owner of Cat Cay in the Bahamas, a member of the board of trustees of the International Oceanographic Foundation, and a man keenly interested in the growing field of marine science, came as a profound shock to all of the officers and to those members of the Foundation who knew and loved him. Mr. Wasey was a good and enthusiastic friend to marine science and to the Foundation. Not only did he contribute personal and financial aid to the development of research and education, but he was instrumental in opening the eyes of many of his friends to the absorbing interest of the growing field of oceanography.

Mr. Wasey obtained ownership of Cat Cay, South Cat Cay, and Gun Cay islands in the very early 30's. He could scarcely have realized at the time what this move would eventually mean to sports fishing and to the science of the sea, but through the years Cat Cay Club and its friendly host became international symbols of skilled fishing and enduring friendship among the world's finest big game anglers, many of whom are now active members of the Foundation.

Beautiful Cat Cay is a natural monument to Mr. Wasey, whose presence will always be felt there. Jane Wasey, his daughter, will maintain and operate the island as he established it. Those who knew Louis Wasey remember him in highest respect and fond affection.

Science of the Sea in BOOKS

General Reading

DANGEROUS MARINE ANIMALS

BRUCE W. HALSTEAD, M.D. Cornell Maritime Press, Cambridge, Maryland, 1959. 135 pages, 86 text figures, bibliography and index. $4.00.

This important book should be in the library of every marine enthusiast, amateur and professional. The author, director of the World Life Research Institute in California, spent many years investigating, from the medical aspect, the dangers that may be encountered in the sea from some of its denizens. This book is a compilation of his studies, written in easily readable language and will answer many of the hundreds of questions usually posed on this subject.

Chapter 1 presents an interesting historical background to the general subject from the earliest days to the present, setting the scene for the rest of the book. The remaining chapters cover the entire field of dangerous animals: Marine Animals that Bite (from sharks to the giant clam), Marine Animals that Sting (jellyfishs, sea anemones, poison cone shells, bristle worms, sea urchins, fishes from sting rays to scorpion fishes and poisonous sea snakes), and Marine Animals that are Poisonous to Eat, dealing mostly with fish poisoning. In each smaller category under the main heading are listed those species known to be harmful and the medical aspects—treatment and prevention.

In writing a book of such general coverage it became perhaps inevitable that some inaccuracies or questionable or misplaced items should be found. The giant clam for instance does not "bite" with its massive shell, and this reviewer would appreciate reading of a single authentic instance of anyone being killed by one. There are no case histories in the literature. Also that a poisonous snake "stings" seems inappropriate in either popular or scientific language.

A very possible danger to the layman unacquainted with Dr. Halstead's work and seeing the large number of animals covered, is that he will come to regard the sea and its creatures with undue fear and caution. This reviewer has spent his entire life in and on the sea and believes that most of the dangers of the sea result from man's own inexperience and neglect of common reason and that the most dangerous objects in the sea are broken bottles thrown into it by unthinking picnickers.

Nonetheless, this book will be of considerable aid to yachtsmen, biologists both professional and amateur, and physicians, especially in those areas of the world where dangerous marine animals predominate. G.L.V.

THE SKIN DIVER

ELGIN CIAMPI. The Ronald Press Company, New York. 1960. 315pp. $5.50.

Elgin Ciampi, who for seventeen years has been skin-diving, photographing, and exploring the underwater world, has compiled a practical handbook indispensable to the novice skin diver.

The book covers all aspects of skin diving from snorkeling to building a submarine scooter, and guides the beginner with explicit step-by-step instructions, emphasizing the safety of the individual and the pleasure of

underseas adventure that can be his when he is confident of his own skin-diving proficiency.

After covering the basic equipment and techniques necessary, the author introduces his readers to what they may find in the way of marine life and wreckage to be explored underwater, and describes the art of underwater photography. His optimism about the search for buried treasure may lead to disappointment for some who do not "hit the jackpot" in their explorations, yet his enthusiasm is a tonic that will surely send them back for another search.

The book is well-illustrated with photographs, line drawings, and charts, and even the experienced diver will find it an excellent reference volume for facts and figures that sometimes slip the mind. P. P.

THE LOST TREASURE OF COCOS ISLAND

RALPH HANCOCK and JULIAN A. WESTON. Thomas Nelson & Sons, New York. 325 pages. Index. 1960. $5.00.

The search for buried treasure goes on and on, with no sign of abating. So do books about where it might be found, and how to go about retrieving it. (Could it be that there is more money in books than treasure chests?)

Lonely Cocos Island, 550 miles due west of Panama City, has spurred the imagination of hundreds of adventurers ever since the booty of the British merchantman *Mary Dear* was buried there in 1821. Reputedly the largest such hoard in the world, no part of it has ever been found.

This exciting book is a recounting of the efforts of the many who tried, through the use of science and many ingenious devices, as well as dogged persistence, trickery and even bloodshed to uncover the booty. A big book, it is a *must* for the treasure hunter, actual and armchair. E.J.L.

ONLY FOUR ESCAPED

C. E. T. WARREN and JAMES BENSON. Wm. Sloane Associates. New York. 1959. 219 pp., 20 illus., 6 maps & diag. $4.50.

This book relates the sinking of the British submarine H. M. *Thetis* on June 1-2, 1939, with 103 men on board. Only four escaped. The thrilling story is told from the viewpoints of men aboard the boat, and of those at the surface trying to rescue them. The tragedy occurred during shakedown of a brand new vessel, while England was still at peace.

One short chapter summarizes findings of the Tribunal of Inquiry, the authors demurring on at least one official finding. For instance, the event which precipitated the sinking was opening of the rear door to a forward torpedo tube, mistakenly believed by the crew to be clear of water and securely shut off from the sea by a vital valve.

Neither assumption was correct. The tube was full of water and the valve between it and the sea was wide open. The authors believe that the valve was open and that the tube was full of water before *Thetis* left her berth (mistake of yard personnel under Admiralty supervision) and that the error could and should have been detected by the crew while under way. The official view, however, was that the tube was flooded "not many minutes before the accident" (by mistake of crew alone).

The hopeless muddling of surface rescue operations, effects within the sub of oxygen depletion and build-up of carbon dioxide resulting in gradual suffocation of personnel, and failures of the Davis Submarine Escape Apparatus to function properly under the circumstances are vividly related. The graphics are well chosen. A few more line drawings or photographs of key compartments would have helped clarify the narrative. For instance, it would have been relatively

simple to have presented a series of line drawings showing step by step exactly where flooding occurred and to what depths; trim of the hull; relationship of the sub to surface and bottom, etc. These facts all appear in the text, but in order to reconstruct the chain of events the reader must wade through considerable narrative, interesting though it is.

The book should rank as "must" reading for submariners. The general reader will find it a well documented, absorbing "sea story." J.K.M.

FRONTIERS OF THE SEA

ROBERT C. COHEN. Doubleday & Co., New York. 1960. 307 pages. Bibliography and Index. $4.95.

Although not himself an oceanographer, Mr. Cohen has done a remarkable job of assembling much that is known, past and present, about a new and rapidly developing branch of science. For the average person interested in expanding his horizons of knowledge, *Frontiers of the Sea* is an up-to-date handbook, the subject matter of which ranges from the origins of the oceans and their basins to glimpses into the future effects of sea-dumped atomic wastes on oceanic creatures *and us*. New devices for the exploration of the depths are described, as well as "The Mohole Project" to bore through the crust of the earth beneath the sea.

The book makes its best point when the author emphasizes the free world's need for more and better research ships, because the study of the oceans is necessarily an expensive, large-scale operation. "The motley fleet with which American oceanographers have had to 'make do' simply is not adequate for the job," the author declares, calling for a doubling of funds for basic research. Some thought must be given soon, he adds, to an even more serious aspect of oceanography — how the ocean's resources are to be distributed among the nations. Altogether this is a comprehensive, thought-provoking book, well illustrated and packed solid with details and stories of a world larger and more various than the land. E.J.L.

Technical Reading

THE BIOLOGY OF MARINE ANIMALS

J. A. COLIN NICOL. Interscience Publishers. New York and London. 1960. 707 pp. Illustrated. $14.00.

Few marine biologists can afford to be without this book, which provides a long-needed compilation of our knowledge of the comparative physiology of marine animals. It is sufficiently concerned with the relation of physiology to the peculiar conditions of marine environments and to the behavior and requirements which these conditions evoke, that it will be welcomed by the ecologist and naturalist as well as by the physiologist. In short, it is a book for the biological oceanographer as well as for the summer laboratory marine biologist. The author is to be commended for what should remain a standard work for some years to come. F.G.W.S.

FISHING BOATS OF THE WORLD

JAN-OLOF TRAUNG. Edited from papers and discussions, Second World Fishing Boats Congress, Rome 1959. Fishing News (Books) Limited, London, 1960. 820 pp. Seven guineas. ($20.60)

Weighing over six pounds, the 820 large pages which comprise this book will form a highly valuable reference to the fishing interests of the world. It includes the major papers and discussions of the week-long Second World's Fishing Boats Congress held in Rome in 1959. Mr. Traung has added to this several important additional contributions from experts

throughout the world. The Congress itself was attended by nearly 500 scientists, technicians and practical fishermen, all concerned with more efficiently increasing the world's supply of sea food for the ever-growing human race.

The book is divided into four major parts, each practically being a book in itself. Part I, Tactics, deals with the influence of varying fishing methods, deck arrangements, etc., for different types of boats. Part II deals with materials, new and old assessments, fishholds, installation of machinery, and costs. Part III, covering Sea Behaviour, gives model tests and actual experiences and is particularly valuable to the naval architect, owner or skipper. Part IV, Productivity, gives a symposium on types of boats suitable for varying classes of fishing. A summary of each article is given in French and Spanish. All measurements in text and tables are in feet and the metric system and, to facilitate ready reference, the index is collated with that of the first "Boats" book, as well as the current volume.
Though technical, the book is intensely practical in its aim of improving the standard of fishing boat design all over the world and so contributing to larger and more economical catches. The function of the Food and Agriculture Organization of the United Nations is to increase the food supply of the world. So far as sea food is concerned a measure of success is being secured. Since 1953, when the first Congress was held, the world's catch has grown from 25 m. tons to 33 m. tons in 1958. Scientists believe it can be lifted to 60 m. tons without detriment to stocks. For fishery administrators, technicians, naval architects, boat builders and fishing craft operators this book will prove invaluable not only for its basic knowledge but for the inspiration it gives to future development. — F. G. W. S.

THE DESIGN OF SEA DEFENCE WORKS

ROLAND BERKELEY THORN. Butterworth Scientific Publications, London, 1960. 102 pages, 75 line drawings and halftones, seven graphs. $5.00.

The author has chosen for the flyleaf a quotation from Shakespeare's sonnets: ". . . I have seen the hungry ocean gain Advantage on the Kingdom of the shore . . ." The book itself is considerably more down to earth (and sea) and represents a valuable handbook on British practice in sea wall design. Although modern design owes much to trial and error approaches, the author stresses research and treats his subject mathematically. Recommended to engineers concerned with the design of sea walls.
F.G.W.S.

RESEARCHES IN GEOCHEMISTRY

PHILIP H. ABELSON, Ed. John Wiley & Sons, Inc., New York, 1959. 510 pp. $11.00.

An outcrop of a series of seminars, held at the Geophysical Laboratory of the Carnegie Institute in Washington and the Johns Hopkins University, this collection of geochemical papers embraces a wide field of research. Many of the most prominent contributors to the advance of geochemisty have added valuable articles. However, the arrangement of the articles in the book was done at random and no cross references from article to article are found.
It is apparently not the intention of the editor to cover the total field of geochemistry, but only to highlight the most recent advances and important contributions. Each essay gives a general review of a specific topic and covers the recent research of each author. In this way the book is stimulating reading. It also supplies the necessary background and references for some of the most interesting areas in geochemistry. F.F.K.

About The Authors

STEPHEN SCHMIDT

Mr. Schmidt was born December 11, 1925 in New York. He served in the Pacific Theater during World War II and in the Army Air Force.

Upon his discharge in 1946 he attended Mohawk College in Utica, New York and the University of New Mexico in Albuquerque. He received a B. S. in anthropology from the University of New Mexico in 1951.

In 1958 he was appointed Director of the Martin County Historical Society's House of Refuge Museum and the new Elliott Museum. The Elliott Museum contains three wings devoted to Florida History, Automotive Development, and an Art Gallery. Both museums are located on Hutchinson Island and are free to the public.

P. ROSS WITHAM

Mr. Witham was born April 17, 1917, in Stuart, Florida. He served in the Navy from 1934 to 1944 when he was discharged for physical disability and he was Chief Petty Officer at the time of discharge.

In February, 1960 he received the Florida Sportsman's Club Regional Conservation award in Salt Water Conservation for his work with the sea turtles at the House of Refuge Museum. This award is sponsored by The Florida Wildlife Federation and the Sears Foundation.

Mr. Witham is presently employed as supervisor of experimental hydroponic gardens at the Public Health Research Laboratories, Stuart, Florida. His avocation is Curator of Turtles for the House of Refuge Museum.

DR. GENE A. RUSNAK

Although Dr. Rusnak is a native Midwesterner, the sea early became a major force in his life. His work at the University of Chicago, combined with the invitation by Johns Hopkins University to conduct research in geological oceanography at the Chesapeake Bay Institute, served to intensify his interest in the oceans. Consequently, in 1955 he joined the staff of the University of California's Scripps Institution of Oceanography.

Dr. Rusnak's special interests are in the distribution and form of marine sediments, with emphasis on chemical controls as a means of interpreting the past geological history of the earth. While in California, he conducted studies in the Pacific and the Gulf of Mexico. His position now as an Assistant Professor of Marine Geology at the Institute of Marine Science at the University of Miami facilitates the work on his most recent project. At present, Dr. Rusnak is studying the deposition of limestones and carbonate sediments in the tropical and subtropical environment of the Bahamas and the Caribbean.

Growth

MEMBERS are to be congratulated that their numbers have continued to multiply every twelve months in the few years since the Foundation began its work. They are drawn from the United States, Canada, Central and South America, Great Britain, Australia, France, Germany, Italy, Turkey, Denmark, Sweden and Norway as well as a few from the Pacific Islands, the West Indies and Russia.

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IN ADDITION TO PUBLISHING *Sea Frontiers* and *Sea Secrets,* the Foundation provides active support for scientific research and education. The ocean is our last frontier and its exploration still under way.

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THE EDITOR will be glad to consider for publication articles and illustrations covering explorations, discoveries or advances in our knowledge of the marine sciences or describing the activities of oceanographic laboratories or expeditions in any part of the world.

The International Oceanographic Foundation

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"To encourage the extension of human knowledge by scientific study and exploration of the oceans in all their aspects, including the study of game fishes, food fishes, ocean currents, the geology, chemistry, and physics of the sea and the sea floor."

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